Ref. Ares(2024)3196987 - 01/05/2024

Grant agreement No. 101069852

Move2CCAM

MethOds and tools for comprehensive impact Assessment of the CCAM solutions for passengers and goods

HORIZON-CL5-2021-D6-01

D4.1

The MOVE2CCAM Impact Assessment Tool – Beta version

WP4 - MOVE2CCAM Impact Assessment Tool

Dissemination Level		
PU	Public	X
SEN	Sensitive	

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Information

Due date of deliverable	Month 20 – April 2024
Actual submission date	Month 20 – April 2024
Start date of project	01/09/2022
Duration	30 months
Lead beneficiary	MOBY
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Document history

Version	Date	Released by	Comments
0.1	01/02/2024	MOBY	Initial Version with ToC
0.2	04/01/2024	MOBY	First consolidated version, submitted for internal review
0.3	22/04/2024	UCL	Internal review comments addressed
1.0	25/04/2024	MOBY	Final version for submission

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Acronyms and definitions

Acronyms	Definitions
SD	System Dynamics
CCAM	Cooperative, Connected, and Automated Mobility
IAMT	Impact Assessment Tool
NUTS	Nomenclature of Territorial Units for Statistics
KPI	Key Performance Indicators

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1. Introduction

As transportation systems evolve to meet the demands of an increasingly interconnected world, the integration of innovative technologies becomes paramount in ensuring efficiency, sustainability, and safety. In this pursuit, the MOVE2CCAM Impact Assessment and Modelling Tool (IAMT) emerges as a pioneering endeavour, poised to revolutionize the evaluation of Cooperative, Connected, and Automated Mobility (CCAM) systems. Led by MOBY, in collaboration with a consortium of experts, the development of this tool represents a significant milestone in advancing the understanding and implementation of CCAM technologies.

Overall, this deliverable addresses the objectives related to WP4 that are: a) to set the ground on designing the systems dynamic model for quantifying the systems-wide impact of CCAM use cases and scenarios, b) to initiate the process on designing the software/platform and the web application through which the IAMT will be accessible to interested stakeholders in an easy and user-friendly way, c) to design the initial graphic interface that will be connected to the software including the visualisation dashboard, d) to initiate the process of applying, testing and validating the IAMT software in the three prototypical regions and work with them to get feedback and finalise the tool and lastly e) to start the initial discussions on integrating the IAMT software to the BABLE platform to secure the exploitation and sustainability of the tool. The tasks that are related to this deliverable (D4.1) are: T4.1 CCAM systems dynamic modelling, T4.2 MOVE2CCAM impact assessment tool technical design and T4.3 KPI calculator and visualisation dashboard.

At its core, the tool embodies a comprehensive approach towards evaluating the multifaceted impacts of CCAM systems. This beta version of the tool sets the stage for a paradigm shift in assessing the transformative potential of emerging transportation technologies. By presenting a detailed conceptual architecture, a visualisation dashboard including Key Performance Indicators (KPIs), and the intricate technical design, this report serves as a foundational resource for stakeholders across academia, industry, and policymaking realms.

The **conceptual architecture** of the CCAM systems dynamic model forms the backbone of the tool. Rooted in robust theoretical frameworks and informed by real-world data, this model captures the complex interplay of variables inherent in CCAM systems. From vehicle-to-vehicle communication protocols to infrastructure integration strategies, every facet of CCAM deployment is meticulously analysed within this dynamic framework. Such a holistic approach ensures that the tool is equipped to navigate the intricacies of contemporary transportation landscapes.

Central to the efficacy of the tool is the **visualisation dashboard**, designed to provide stakeholders with actionable insights into the performance of CCAM systems. Through a curated selection of key metrics, this dashboard offers a comprehensive overview of various dimensions, including safety, efficiency, environmental sustainability, and societal impacts. By synthesizing vast amounts of data into accessible visualizations and performance indicators, the KPIs dashboard empowers decision-makers to make informed choices regarding the deployment and optimization of CCAM technologies.

Furthermore, the **technical design** of the tool exemplifies a commitment to excellence in engineering and innovation. Leveraging cutting-edge methodologies in software development, data analytics, and simulation techniques, this tool embodies the convergence of technology and transportation expertise. From algorithmic optimizations to user interface design, every aspect of the technical architecture is meticulously crafted to ensure usability, scalability, and reliability.

This deliverable presents the beta version of the tool, including a detailed conceptual architecture, the visualization dashboard, and the intricate technical design. During the past 20 months, the theoretical and mathematical foundation of the tool were set up, while also producing the ongoing visualization dashboard of the tool and initiating discussions about enhancing the exploitability and sustainability of the tool.

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2. Conceptual architecture of CCAM Systems Dynamics Model

2.1. IAMT Framework

The framework of the tool outlines the structure and components of a software tool designed to assess the potential impacts of various interventions, policies, or projects on a given system, environment, or community. The framework typically encompasses several interconnected elements aimed at facilitating the analysis and understanding of potential consequences. The IAMT being developed in Move2CCAM will assess the impacts of CCAM use cases in different domains, namely, mobility, human health, land use, environment, economy, equity, safety, and network efficiency in different EU regions.

2.2. IAMT Flowchart

This section presents the sequential steps and decision points involved in conducting an impact assessment while leveraging system dynamics methods, where collected data from different EU regions are incorporated in the model. Based on the collected data the predefined KPIs are calculated concerning the 8 domains of interest (mobility, human health, land use, environment, economy, equity, safety and network efficiency). Therefore, the System Dynamics modelling estimates the parameters of each KPI reflecting the impacts that every domain has on the CCAM modes. Calibration of the model is undertaken for validating the results of the model.

From a scenario testing perspective, a machine learning analysis will be able to forecast the data based on historic information and thus to provide the information required to estimate the parameters of the KPIs on a requested future year. The obtained results will be able to support strategies in policymaking for enhancing existing strategies for promoting CCAM modes. Figure 1 illustrates the flowchart of the IAMT framework. The region of interest is selected along with the import of secondary data (data sources outside of the project) in the data warehouse that also stores the primary data (data sources from the project). The values of the variables are predicted using machine learning techniques utilising historical data and the use case(s) of interest is selected for further analysis. Subsequently, the model is calibrated and using system dynamics modelling techniques, the impacts are estimated for the baseline year. Further, the estimates are forecasted for the subsequent years providing results up to 2050 via scenario testing. Finally, the diagrams, maps and statistics are illustrated in the visualisation dashboard in the form of KPIs that can lead to comparative policymaking analysis.

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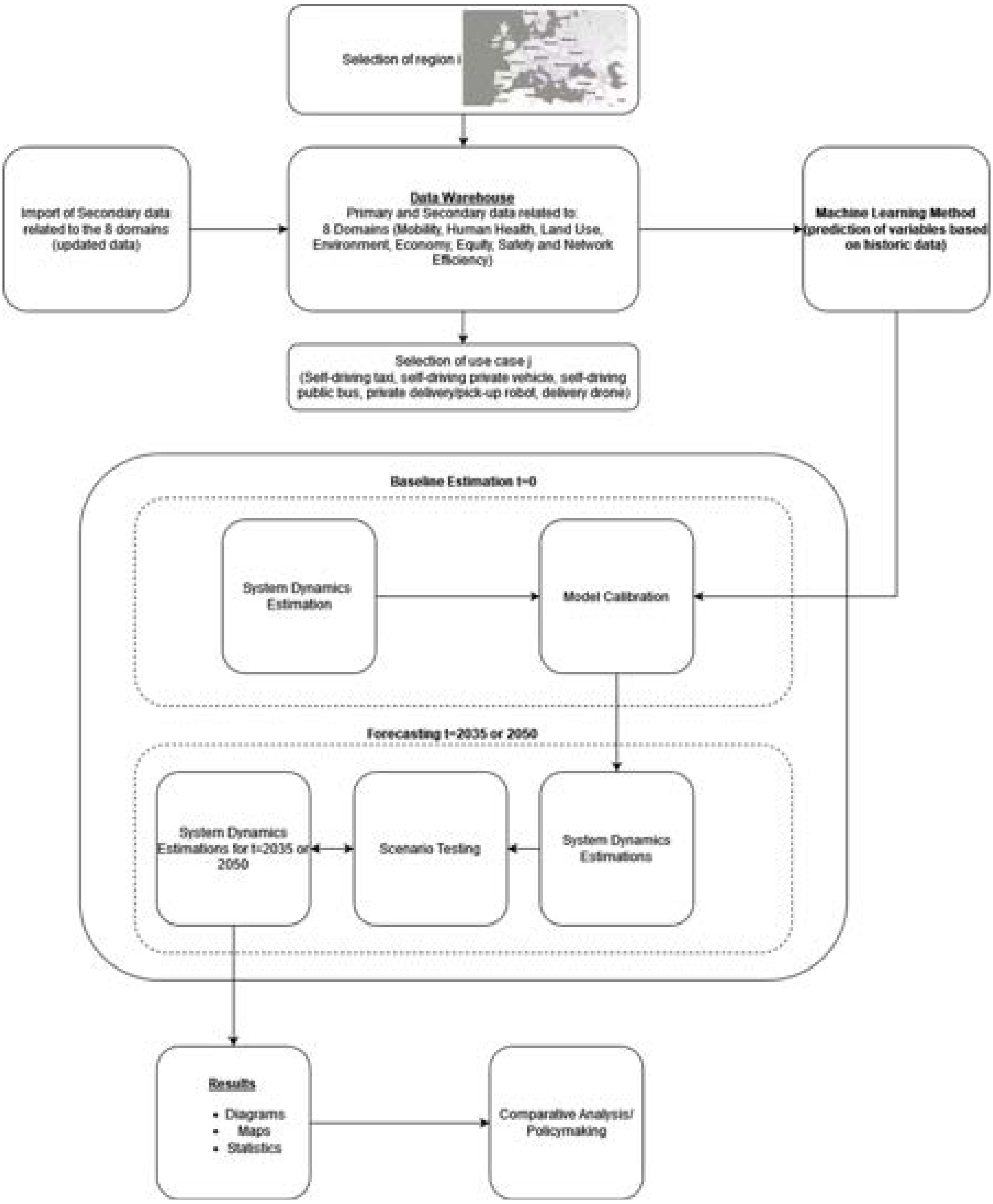

Figure 1: Flowchart of the IAMT framework

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2.3. System Dynamics modelling

2.3.1. General Information

System Dynamics is a methodology used to understand and model complex systems over time. It focuses on the feedback loops and time delays within a system and analyses how they behave dynamically. The principals of System Dynamics modelling are[1]:

- **Feedback Loops**: Systems often contain feedback loops where the output of a system influences its input. Feedback can be either reinforcing (positive) or balancing (negative).
- **Time Delays**: Changes in a system may not have an immediate effect. There can be delays between actions and their consequences, leading to dynamic behavior.
- **Stocks and Flows**: System Dynamics models represent quantities that accumulate or deplete over time (stocks) and the rates at which these quantities change (flows).
- **Nonlinearity**: Relationships within systems can be nonlinear, meaning small changes can have disproportionate effects.
- **Emergent Behavior**: System Dynamics models capture the emergence of complex behaviors from the interaction of simpler components.

The steps of System Dynamics modelling are identified as follows:

- **Conceptualization:** The first step involves identifying the key components, relationships, and feedback loops within the system. This is often done using causal loop diagrams to visualize the structure of the system.
- **Formulation**: Mathematical equations are used to represent the relationships between variables in the system. These equations describe how stocks change over time based on inflows, outflows, and feedback loops.
- **Simulation**: System Dynamics models are simulated over time to understand how the system evolves dynamically. Simulation helps to test different scenarios and policies to see their impact on system behavior.
- **Validation**: Models are validated by comparing their outputs to real-world data or expert knowledge. Validation ensures that the model accurately captures the behavior of the system it represents.
- **Policy Analysis**: Once validated, System Dynamics models can be used to explore the effects of different policies or interventions on system behavior. This helps decision-makers understand the long-term consequences of their actions.

Based on the principals and the steps of System Dynamics, the collected data (primary and secondary) are integrated in the model to inform the formulation and validation of the model. In detail, the collected data is used to estimate the parameters of the mathematical equations that describe the system and to calibrate the model so that it accurately reproduces historical behaviour. This involves adjusting model parameters to minimize the difference between simulated and observed data. Furthermore, collected data is used for validating the model by comparing model outputs to real-world data. If the model accurately reproduces historical behaviour and can make accurate predictions, it is considered validated. The data is also used in sensitivity analysis to understand how uncertainties in input parameters affect model outputs. This helps identify which parameters have the greatest influence on model behaviour and where more data collection or research may be needed.

Overall, integrating data into System Dynamics modelling helps improve the accuracy and reliability of the model, making it a valuable tool for understanding and managing the CCAM use cases based on the different contexts (e.g., economic) of different EU regions.

[1] *Bilash Kanti Bala, Fatimah Mohamed Arshad, and Kusairi Mohd Noh. 2018. System Dynamics: Modelling and Simulation (1st. ed.). Springer Publishing Company, Incorporated.*

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2.3.2. Analysis

System Dynamics models typically involve differential equations that represent the accumulation of quantities over time (i.e. stocks) and the rates of change between different variables (i.e. flows). Equation 1 below shows the type of equations included in the Move2CCAM systems dynamics model.

$$\frac{dS_{ij}}{dt} = f(\widehat{Mob_J}, \widehat{HH_J}, \widehat{LU_J}, \widehat{Env_J}, \widehat{Ec_J}, \widehat{Eq_J}, \widehat{Saf_J}, \widehat{NE_J}, \widehat{S_J})_{ML} \quad (1)$$

,where,

- S_{ij}: Represents a stock variable (e.g., number of vehicles/trips of a use case *i* for region *j*).
- $\hat{S}_j$.: Predicted values of stock variable
- $\widehat{Mob}_j$.: Predicted values of mobility domain
- $\widehat{HH}_J$: Predicted values of human health domain
- $\widehat{LU}_J$: Predicted values of land use domain
- $\widehat{Env}_J$.: Predicted values of environmental domain
- $\widehat{Ec}_J$.: Predicted values of economic domain
- $\widehat{Eq}_J$.: Predicted values of equity domain
- $\widehat{Sa}_{\iota J}$: Predicted values of safety domain
- $\widehat{NE}_j$: Predicted values of network efficiency domain
- ML: Represents the subtle incorporation of Machine Learning techniques, where the machine learning model (ML) could dynamically adjust parameters influencing the domains based on historical data or real-time inputs.

Each domain is interpreted by different variables relevant to the domain of interest. For example, Equation 2 provides information for the estimation of the domain of Economy:

$$\widehat{Ec}_j = Ec_{1j}^{0,t} + Ec_{2j}^{0,t} + Ec_{3j}^{0,t} + \cdots + Ec_{nj}^{0,t} \quad (2)$$

where, $Ec_{1j}^{0,t} + Ec_{2j}^{0,t} + Ec_{3j}^{0,t} + \cdots + Ec_{nj}^{0,t}$ refers to all the *n* number of variables related to the economic domain and that refer to the baseline (0) and for any other time instance (t). A diagram illustrating the above equations is presented in Figure 2.

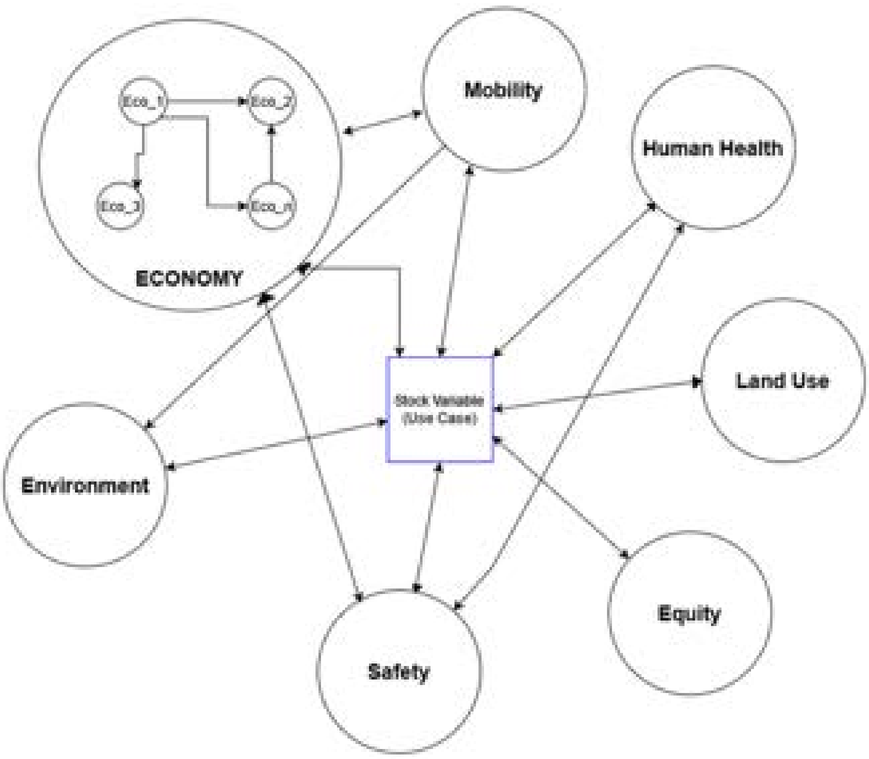

Figure 2: Diagram presenting the interrelationships between the variables analysing the different use cases

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While systems dynamics traditionally rely on differential equations, the integration of Machine Learning can enhance the model's predictive capabilities and adaptability to complex systems. Machine learning techniques, such as regression, classification, or clustering, can be incorporated to analyze historical data, identify patterns, and inform parameter estimation or model calibration within the systems dynamics framework.

Machine learning algorithms, such as optimization or regression techniques, can be used to estimate parameters or calibrate SD models based on observed data. For instance, regression analysis can be employed to determine the relationships between model inputs and outputs, allowing for more accurate parameter estimation.

By subtly integrating Machine Learning techniques within SD modeling, practitioners can leverage the strengths of both methodologies to enhance the analysis, understanding, and predictive capabilities of complex systems. This integration allows for more dynamic and adaptive modeling approaches, enabling better decision-making and system optimization.

2.4. Data

2.4.1. Use Cases – primary data

Based on the Activities 1-3 involving Satellites in the eight countries, data information was collected concerning several use cases for self-driving vehicles including passenger and freight transportation. These use cases cover almost all use cases mentioned in the literature, but also include new variants, especially those involving the collective use of vehicles, by passengers and companies that have similar transport needs. These use cases were consolidated into five use cases, namely, self-driving taxi, self-driving private vehicle, self-driving public bus, private delivery/pick-up robot and delivery drone that will be used in the pan-European survey (Activity 6) and the tool. The characteristics of each use case are provided below in Figure 3-Figure 7.

Figure 3: Characteristics of the self-driving taxi

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Figure 4: Characteristics of the self-driving private car

Figure 5: Characteristics of the self-driving public bus

Figure 6: Characteristics of the private delivery-pick-up robot

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Figure 7: Characteristics of the delivery drone

2.4.2. Causal Loop Diagrams – primary data

In a typical systems dynamics modelling configuration, the first step is to identify the causal loop diagrams that provide the interrelationships between variables (meaning that one variable is positively or negatively associated with another variable) and the feedback loops. The causal loop diagrams are derived from an extensive literature review. Nonetheless, the approach adopted for the configuration of the tool extends this process. Specifically, initial diagrams were identified for the final list of use cases based on rigorous literature review. These diagrams were included during activities 4 (*Final CCAM scenarios and KPIs & CCAM impact - Organisations*) and 5 (*Final CCAM scenarios, KPIs & CCAM Impact – Citizens*), which consisted of workshops in which organizations and citizens gave feedback on factors that might have a (positive or negative) effect on different use cases, focusing on the 8 Move2CCAM domains (mobility, human health, land use, environment, economy, equity, safety and network efficiency). For instance, Figure 8 illustrates an example of the factors identified by participants for the use case of self-driving taxi (passenger transportation), whereas Figure 9 presents an example for the use case of delivery drones. This primary information is essential for capturing the perceived impact of different factors on different use case for the different regions. This process has two purposes: 1) to provide the final causal loop diagrams in the form of co-creation process by enabling the Satellites of the project to co-create the diagrams and provide interrelationships that may be missing from the pertinent published studies, and 2) to yield the final list of variables included in the tool.

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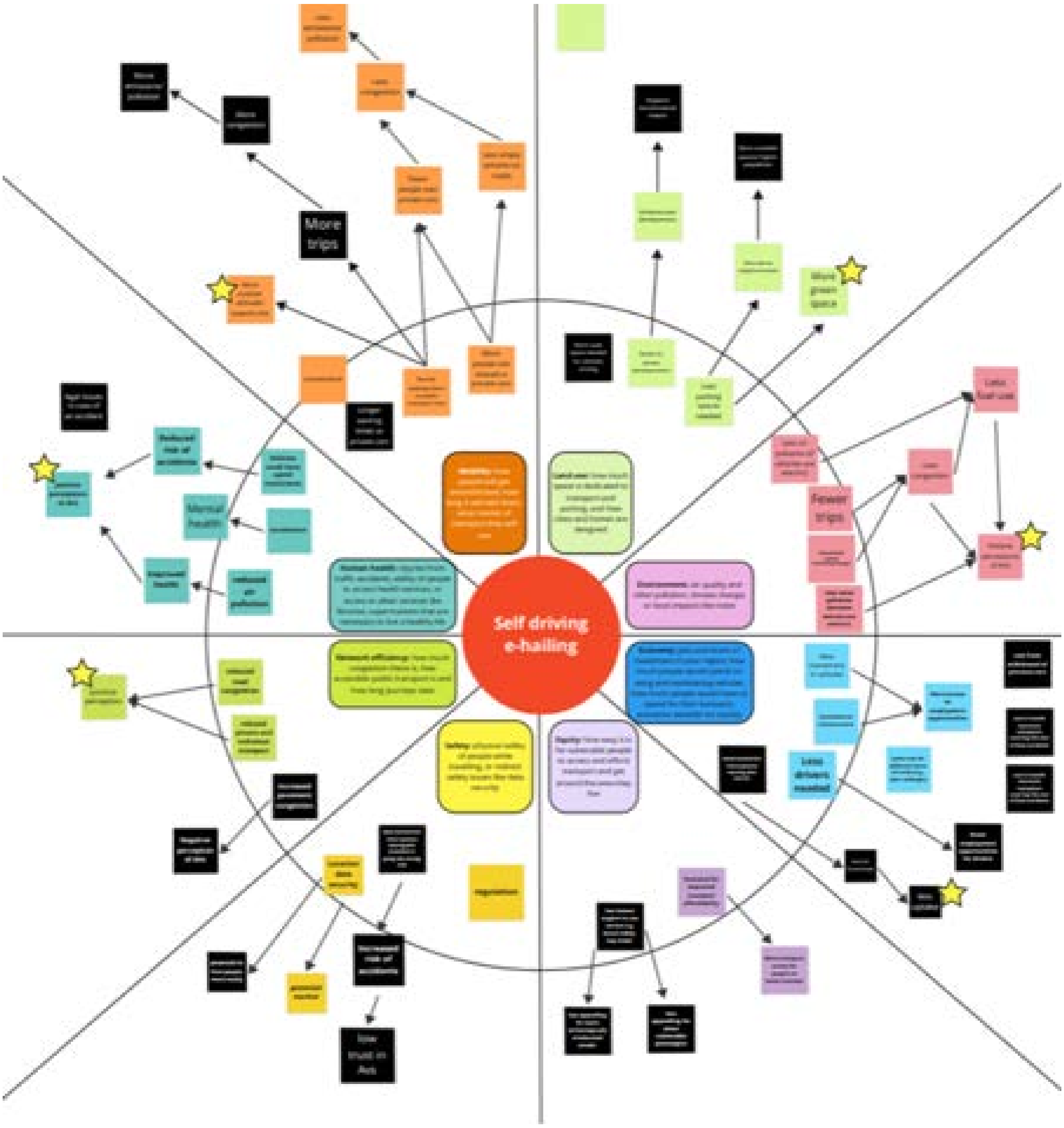

Figure 8: Example of CLD concerning the use case self-driving taxi

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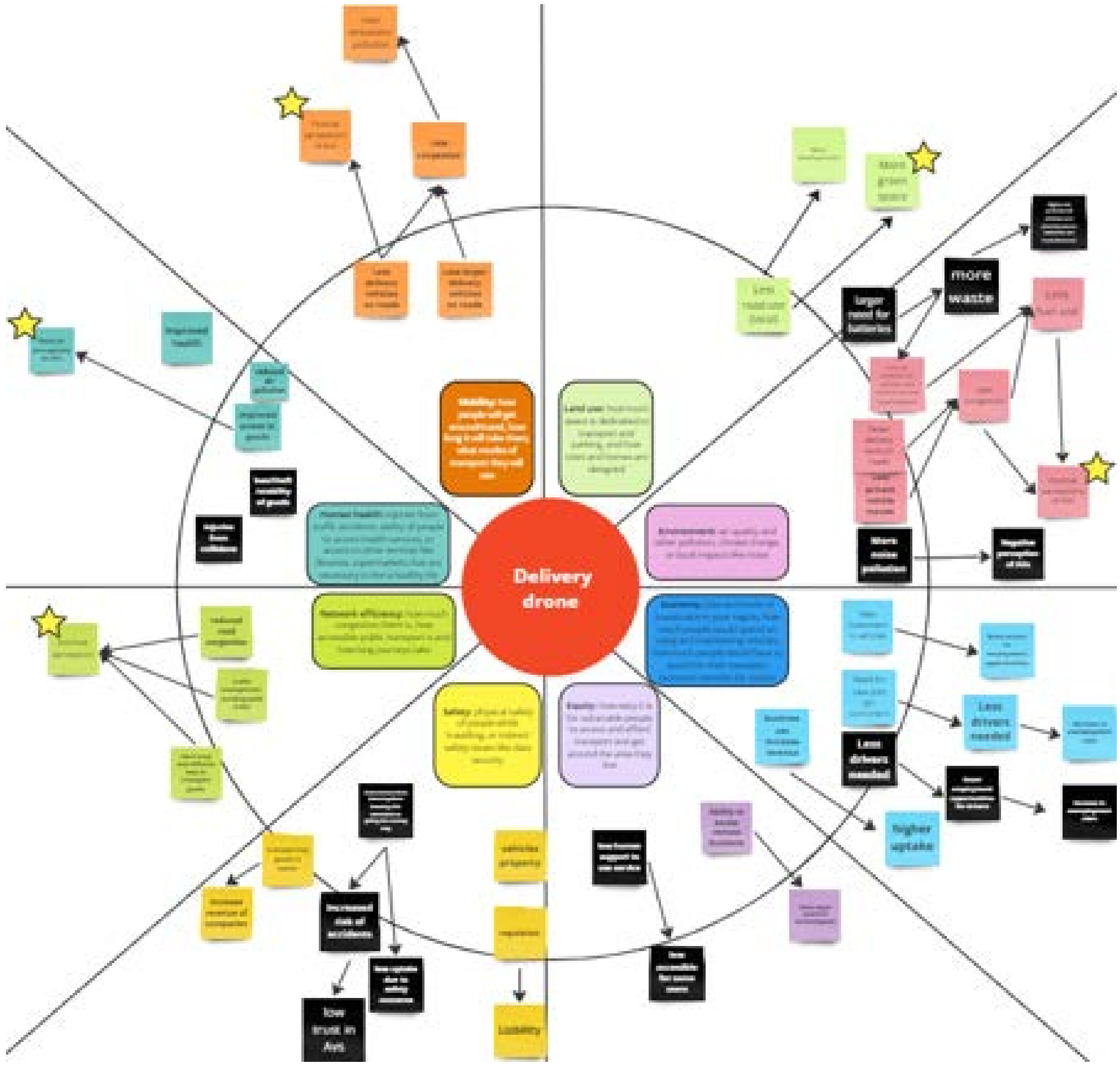

Figure 9: Example of CLD concerning the use case delivery drone

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2.4.3. Secondary data

As described above regarding the objectives of the causal loop diagrams, it is worth noting that this exercise will yield the final list of variables and commence the secondary data collection. Secondary data include variables that are sourced from external repositories and data sources outside of the project (Eurostat, national statistical repositories, completed CCAM-related research projects). This data provides supplementary insights and perspectives and enriches the analytical depth of the tool's impact assessment.

The Move2CCAM IAMT tool will gauge the multidimensional impacts stemming from CCAM passenger and freight use cases within specific regions. To facilitate this assessment, it adopts the 'Nomenclature of Territorial Units for Statistics' (NUTS) 2 classification system. The choice of this classification system has been intentional, aiming to strike a balance between specificity and inclusiveness. This makes it well-suited for informing policies, crafting strategies, and consolidating regional data throughout Europe. Opting for the NUTS 2 system strategically offers a level of detail that is sufficiently comprehensive for meaningful analysis while remaining manageable in scope. Additionally, the standardized nature of the NUTS 2 system offers the advantage of enabling direct comparisons and cross-country analyses. This standardization is particularly valuable given the early stage and limited diffusion of CCAM solutions. Being able to compare regional data at this standardized level is crucial for insightful policy analysis, especially considering the evolving landscape of CCAM technologies and their impacts across diverse regions.

2.4.4. Pan-European Survey – primary data

MOVE2CCAM implemented an online survey with 7500 respondents (500 in Cyprus and 1000 in the other 7 countries: United Kingdom, Germany, France, Spain, Netherlands, Greece, and Poland) as part of Activity 6. The questionnaire was the same in all countries and was translated into the local language. A survey deployed widely across Europe, such as this, is needed to capture aspects such as attitudes towards self-driving vehicles, intention to use, and possible changes in travel behaviour. A sample of 1000 per country was necessary to derive precise results and to ensure that the sample was representative of gender, age, and regions inside the country. The data collection of the pan-European survey is still ongoing, and it is expected to finish within M20-M21. The survey instrument includes four sections, capturing the following aspects: 1)socio-demographic characteristics, 2) travel behaviour, 3) attitudes towards the Move2CCAM use cases, and 4) views regarding the impact of self-driving vehicles on mobility, network efficiency, land use, environment, economy, equity, public health, safety, and security. Modelling techniques such as path analysis and structural equation modelling will evaluate the inter-relationships between participant characteristics, attitudes, and the perceived personal and societal impacts, thereby exploring the multi-systems impact of CCAM.

2.4.5. KPIs Selection

A main list of approximately 250 KPIs was created as part of the efforts of Task 1.2 from existing evaluation frameworks that could be applied to evaluate the impact of CCAM solutions. This list serves as the foundation on which the visualization dashboard is developed and hosted on the MOVE2CCAM systems-wide tool. The shortlist of KPIs was presented in D1.3. The rationale and the selection of the final list of the KPIs that will be included in the tool will be described in the subsequent work packages, primarily in Deliverable 4.2, as the definition of KPIs is anticipated as one of the main outcomes of the satellite co-creation activities that have not taken place yet (Activity 8 – demonstration of the tool).

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3. Technical Design of IAMT and Implementation

3.1. IAMT Specification

Purpose: IAMT aims to provide an interactive platform for creating, analysing, and comparing various transportation scenarios, focusing on automated and connected mobility solutions.

Target Users: Transportation planners, policy makers, researchers, and stakeholders in the field of automated mobility.

Functional Requirements

- **Scenario Creation and Management**: Users can design and store various transportation scenarios, defining regional focus, transport types, and modalities.
- **Data Analysis and Visualization**: The system will analyze transportation data, offering visual representations of critical metrics like emissions, infrastructure investments, and accident rates.
- **Comparative Analysis**: Enables side-by-side comparative assessment of different scenarios, offering insights into optimal transportation strategies.
- **User Authentication**: Robust login functionality that protects user data and personalizes the experience within the platform.
- **Scenario Comparison**: Logged-in users have the capability to save, manage, and juxtapose scenarios against benchmarks or alternate setups.

Technology Stack

- **Frontend**: HTML5, CSS3, and TypeScript for robust, scalable user interfaces, with React.js (or Vue.js as an alternative) for dynamic, single-page application experiences.
- **Backend**: Nest.js is used for server-side logic, offering a scalable environment for RESTful API services.
- **Database**: MongoDB for flexible data storage and retrieval, allowing complex data structures and rapid development cycles.
- **Data Visualization**: Tool integration remains open; however, solutions like D3.js or Recharts for React are potential candidates for creating interactive and detailed data visualizations.
- **Authentication**: Implementation of secure authentication mechanisms using modern standards such as OAuth2, JWT for user session management.

3.1.1. System Architecture

IAMT will be deployed in Docker Environment is in Amazon Web Services (AWS).

- **Client-Server Model**: A distinct division between client (frontend) and server (backend), enabling a clean separation of concerns.
- **Microservices Architecture**: Modular design with the IAMT modeling as a microservice, improving scalability and maintainability.
- **Cloud Deployment**: Containerization (potentially Docker within AWS) for efficient deployment, scaling, and management of application services.

3.1.2. User Interface Design

Layout: Clean and straightforward layout with easy navigation.

Interactive Elements: Dropdowns, sliders, and buttons for user interaction.

Visualization: Graphs and charts for displaying analysis results.

Design: Futuristic design.

Security Protocols

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- **Data Encryption**: Utilization of Secure Sockets Layer (SSL)/Transport Layer Security (TLS) protocols to ensure the secure transmission of data across the network.
- **User Authentication**: Secure user authentication to safeguard against unauthorized access, in order to protect server resources to only be utilized by registered users
- **Data Privacy**: Adherence to data protection regulations, such as the EU General Data Protection Regulation (GDPR), to ensure user data is handled with the utmost confidentiality and integrity.

Risk Management

- **Regular Backups**: Scheduled and systematic backups to prevent data loss, with redundancy across multiple locations for enhanced data safety.
- **Robust Recovery Plan**: Comprehensive disaster recovery procedures to restore system functionality and data access in the event of a system compromise or failure.

3.1.3. Screens

The screens included in the initial visualisation dashboard are discussed below:

1. **Home Page**: A welcoming interface featuring an introductory text, visual elements representing the tool's purpose, and a prominent launch button to begin the scenario testing process.
2. **Choose Area**: A user-friendly interface where participants can choose a country and a region from a list or interact with a world map to select a country, initiating the scenario based on regional data.
3. **Baseline Results**: Upon country selection, this screen presents baseline data results, providing a comparative framework for new scenarios. Logged in users can export their results.
4. **Scenario Settings**: A configuration panel where users can modify various parameters and variables to tailor the prediction model to their specific requirements.
5. **Prediction Results**: A results page that dynamically displays the scenario outcomes after user-customized settings are applied, complete with graphs, statistics, and analytical data.
6. **Log In/Sign Up**: A secure entry point that facilitates new user registration and existing user login, ensuring personalized access and safeguarding user data. Users can navigate the tool even if they are not logged in. However, their access will be restricted since features such as export results, compare scenarios, create new scenarios etc. require the user to be logged in.
7. **Compare Scenario**: After logging in, users gain the ability to save scenarios and compare them against alternative scenarios, different regions, or baseline results for a comprehensive evaluative experience.
8. **Create Scenario**: A clear, action-oriented interface with a "Create Scenario" feature, allowing users to initiate the construction of a new transport model scenario, taking into consideration that they are logged in.
9. **About Page**: An informative section offering deeper insights into the project, its objectives, contributors, and the underlying methodology.
10. **Contact**: A directory screen providing contact information, facilitating user engagement with the project team for inquiries or support.
11. **User Profile**: A profile area where logged-in users can manage their information, preferences, and delete their account.

3.1.4. Architecture and Software Design

The Impact Assessment and Modelling Tool (IAMT) is a technical framework designed to create, analyse, and compare various transportation scenarios, with a focus on automated and connected mobility solutions. This technical representation suggests a system built with modularity and scalability in mind, aiming for high data integrity, interoperability, security, and maintainability.

General

Modularity: Components like the IAMT Frontend, Backend, and Modelling Microservice suggest a modular architecture, allowing for parts of the system to be developed and updated independently.

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- **Scalability**: The use of a message broker (RabbitMQ) implies the system can handle increasing workloads by adding more worker nodes.
- **Data Integrity**: MongoDB as a storage solution suggests a focus on maintaining accurate and consistent data over its lifecycle.
- **Interoperability**: The REST API interface indicates the system is designed to work well with other systems and tools.
- **Security**: Security is a priority, enforced through secure RESTful endpoints and potentially through user authentication mechanisms.
- **Maintainability**: The choice of modern and popular technologies like React, TypeScript, and Node.js suggests a system that's easier to maintain due to community support and standardization.

3.1.5. Architecture

Server Architecture: A client-server model with a web-based application front end communicating with a back-end server via REST API.

Database Management: MongoDB is used to store parameters and results, hinting at a NoSQL approach to data management, which often allows for flexible schema design.

Cloud Deployment: The system uses cloud services for hosting, indicated by the use of containerization and cloud-based data storage (Datawarehouse).

Microservices: The IAMT Modelling component is a microservice, which allows for separate scaling and development of this service. It uses Python, Flask, and Celery, which suggests a lightweight and efficient microservices architecture.

3.1.6. Backend: Implementation of the Modelling Framework

Modelling Framework: It includes a system dynamics model written in R, suggesting the use of statistical computing and graphics.

Additional Modules: User management is a feature of the back end, handling authentication and user-specific data.

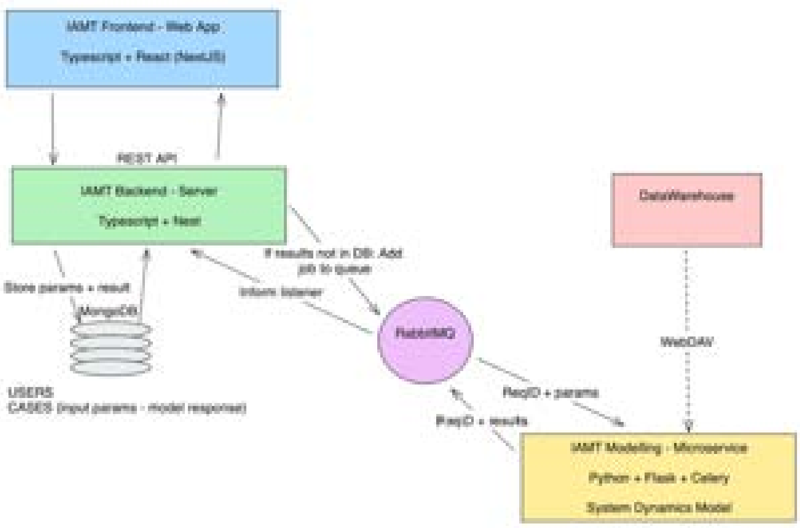

Figure 10: Virtual representation of the backend architecture

3.1.7. Frontend

Web Application: The front end is a web app built with TypeScript and React (potentially with Next.js), suggesting a modern, component-based UI that's interactive and user-friendly.

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3.2. IAMT Visualisation Dashboard

The IAMT, allows the different actors of the CCAM ecosystem (e.g., developers, manufacturers, authorities, etc.) to simulate several CCAM passenger and freight scenarios allowing them to understand in an integrated way the short-, med-, long-term impacts across different systems and get the according KPIs via the visualization dashboard. Figure 11 presents the flowchart of the IAMT's visualisation dashboard.

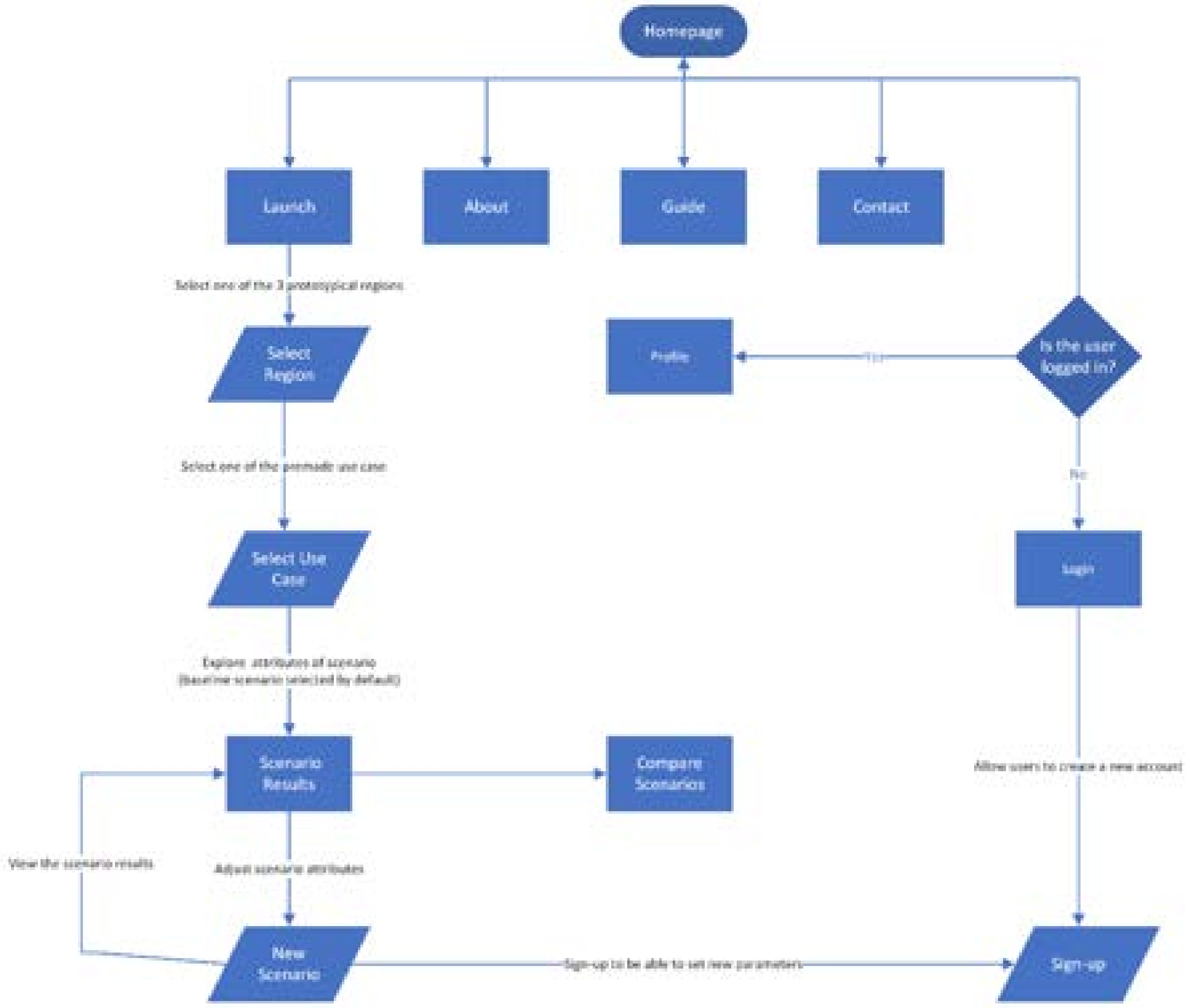

Figure 11: Flowchart of Visualisation Dashboard

The following figures illustrate the visualisation dashboard and the different pages that are displayed for every step of the flowchart presented in Figure 11.

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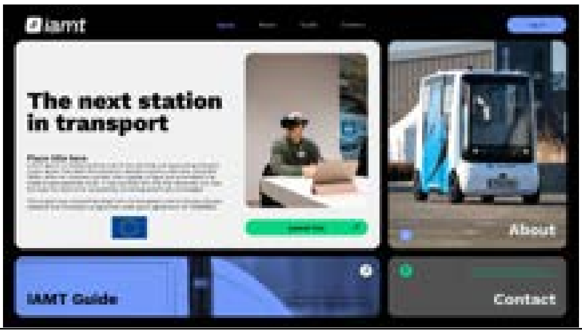
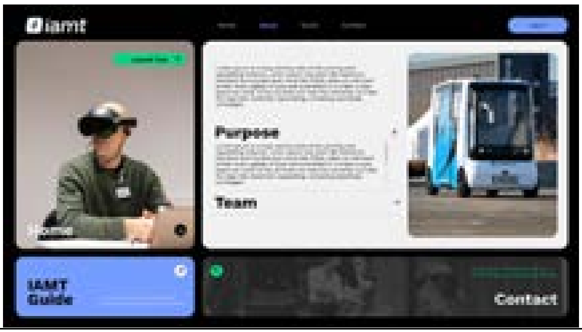
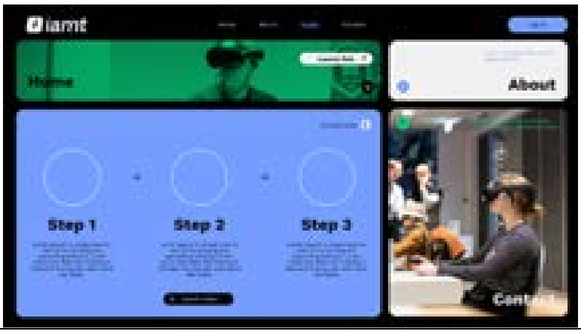
1. Launch



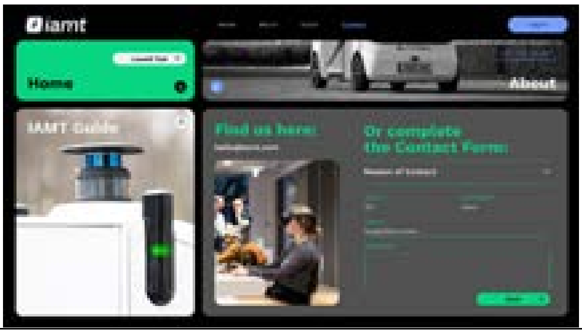
2. About



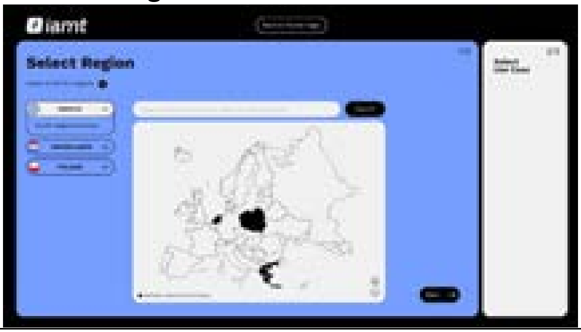
3. Guide



4. Contact



5. Select region



6. Select use case

7. Results of baseline scenario

8. Adjust scenario attributes

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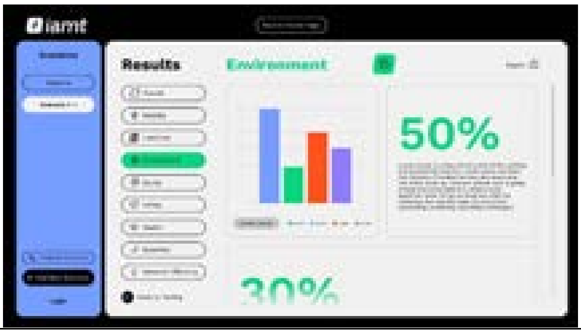
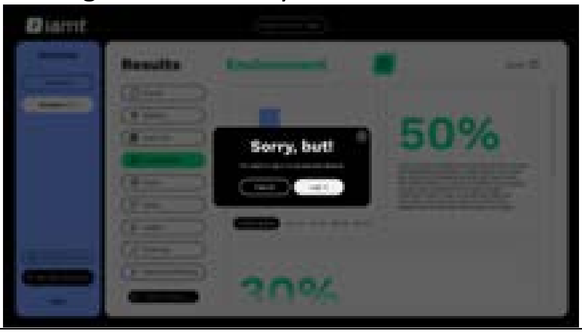
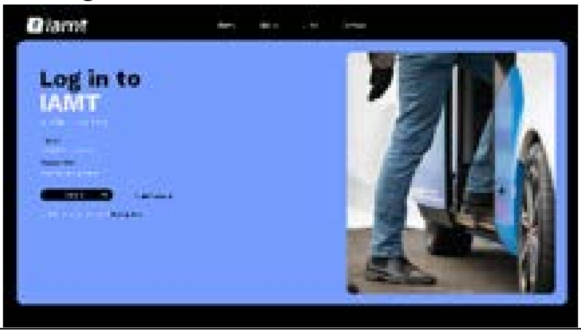
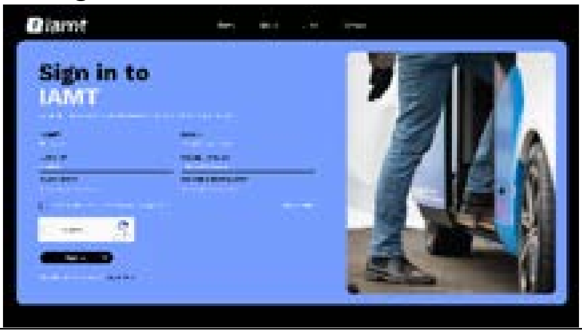
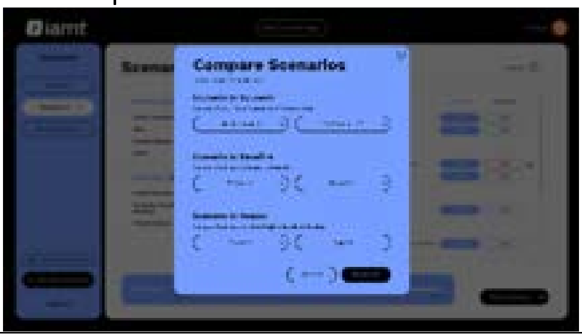
9. Scenario results 	10. Login functionality 
11. Login 	12. Sign in 
13. Select region 	14. Select use case 
15. Baseline results 	16. Compare scenarios 

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4. Next Steps and Preview of D4.2

A comprehensive report that will be delivered for D4.2 will provide the final CCAM systems dynamic model, final visualisation dashboard (including the final KPIs), and the MOVE2CCAM impact assessment modelling tool, which marks a significant milestone following rigorous testing and validation by the Satellites based on collected data (primary and secondary). D4.2 will encapsulate not only the technical aspects of the systems but also user-friendly components essential for effective impact assessment. As a vital part of this documentation, a detailed user manual will be crafted to ensure seamless navigation and utilization of the impact evaluation tool. With insights gleaned from the dynamic model and KPIs dashboard, stakeholders will be able to make informed decisions, leveraging the MOVE2CCAM tool to assess and optimize the impact of their interventions. D4.2 will signify a crucial step forward in advancing CCAM systems and underscores their pivotal role in driving positive change.

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