

BIG-SMART-LOG

“The Use of Big Data Analytics for Process Modelling in Smart Logistics Operations”

Call Topic: Big data and process modelling for smart industry (BDSI), Call 2017

Start date: 01/04/2019

End date: 31/03/2022



BIG-SMART-LOG Partners

- *Ekol Lojistik*
- *Centre for Research and Technology Hellas (CERTH) / Information Technologies Institute (ITI)*



- *Lublin University of Technology*
- *Holisun SRL*
- *Antalya Bilim University*



Project Description

The project aims to address the challenge of redesigning the entire data produced by:

- satellite enabled (IoT) vehicle tracking technology (traffic, weather and road condition information, sensor data with vehicle/load information)
- customers' orders
- third party logistics services (carriers, logistics and terminal operators, etc.),
- open-source systems



Project Description

The goal of the project is to design a semantic-enhanced self-learning processing model which:

- analyzes operational data in real-time
- uses learned data to influence the utilization of existing infrastructure and resources
- increases system resiliency and service quality
- reduces greenhouse gas emissions, fuel consumption, idle times, traffic congestion, revenue losses, late deliveries, customer complaints

Using technologies such machine learning, and deep learning algorithms that will provide predictions to:

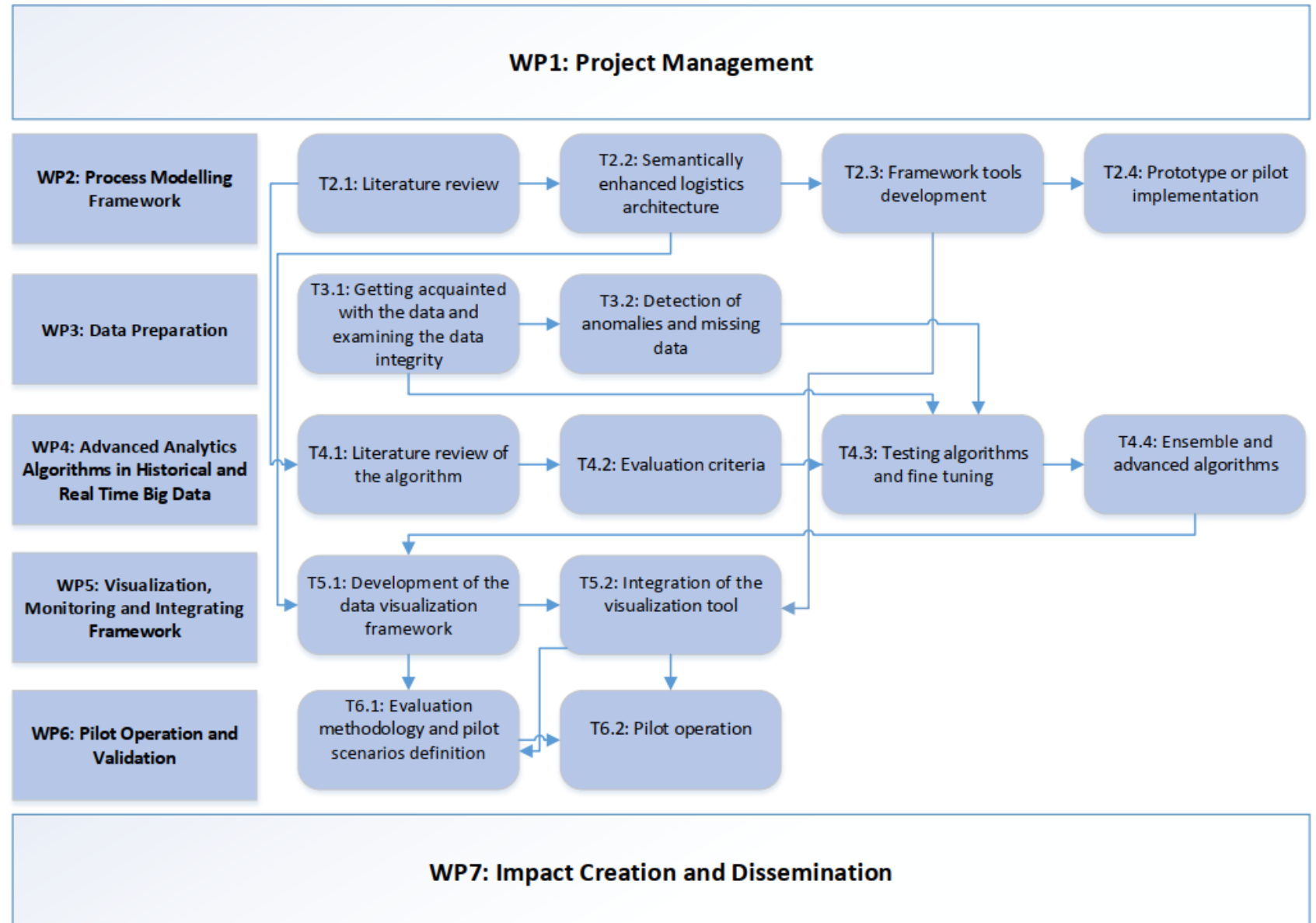
- maximize operational efficiency,
- environmental protection and safety

The outputs of the project will produce a reusable framework for dynamic environments with customizable constraints and parameterized data sources.

Main Objectives

<i>Objectives</i>	<i>Goal</i>
Develop planning systems for freight to find the best (combinations of) modes and optimal route to progress towards freight traceability information allowing better network exploitation and more efficient logistics operations.	10% shorter delivery routes
Having the routes and checkpoint locations optimized, the organization can achieve positive environmental impact of the service via reduced average fuel consumption per parcel.	Decrease 15%
Providing real time information such as traffic jams, weather and road conditions.	Very high
Reduction in driver turnover, driver assignment.	Decrease 15%
Reducing the time spent in transit and idle time.	Decrease 20%
Operational efficiency will be capitalized into increased quality of service to the final customers; from the sender's part, average response time is expected to decrease.	Decrease 30-40%

Project's Structure / Work Packages Dependencies

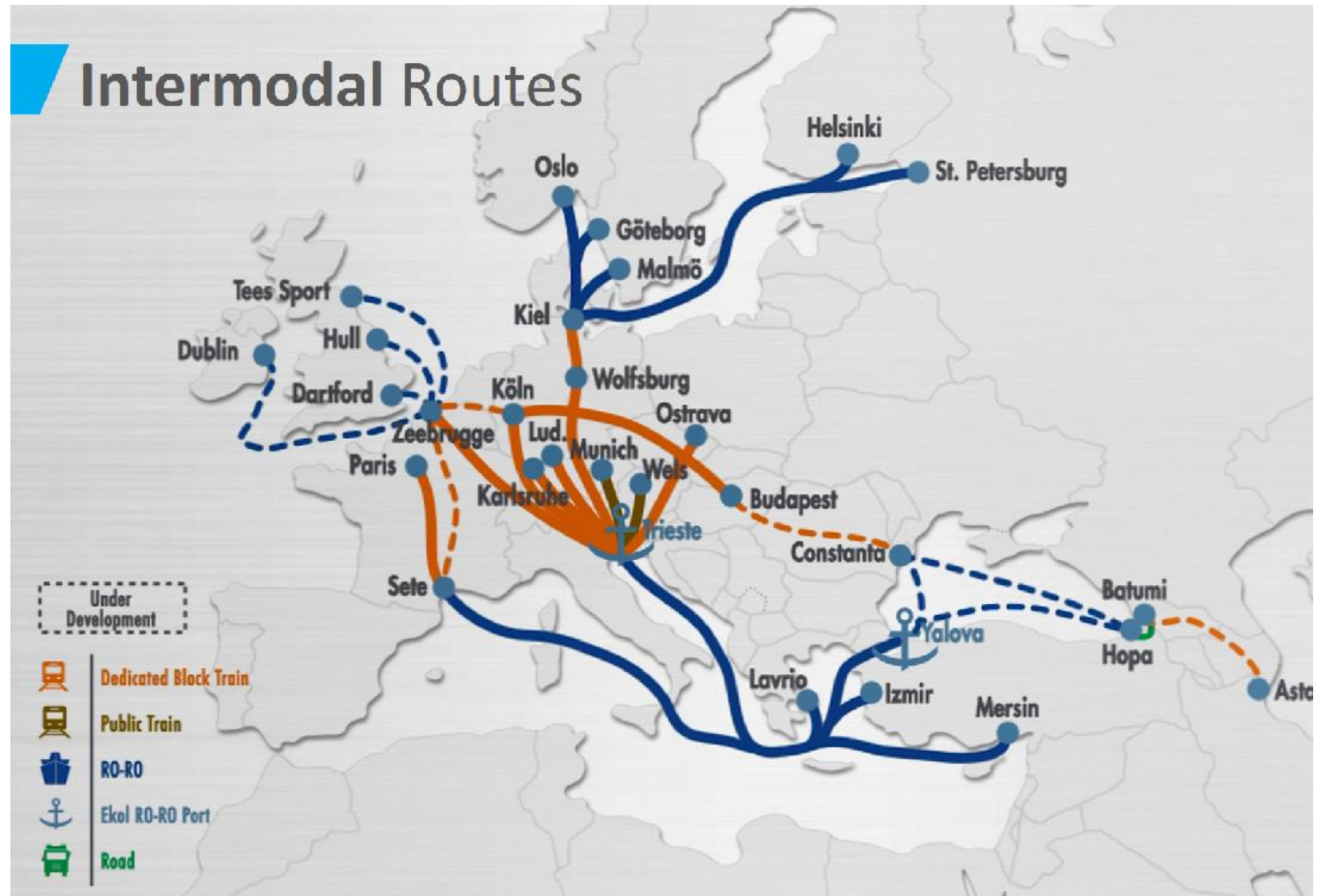


Summary of Achievements

- Collection of business use cases, data and requirements
- Architecture design
- Logistics ontology design
- Literature reviews
- Data pre-processing and initial analysis results
- Scientific publications
- Participation in international events

Business Use Cases

- **UC₁**: Long term forecasting of time and location of future orders
- **UC₂**: Long term forecasting of time and location of pickups and deliveries
- **UC₃**: Forecasting and decreasing late deliveries



Literature review of the algorithms

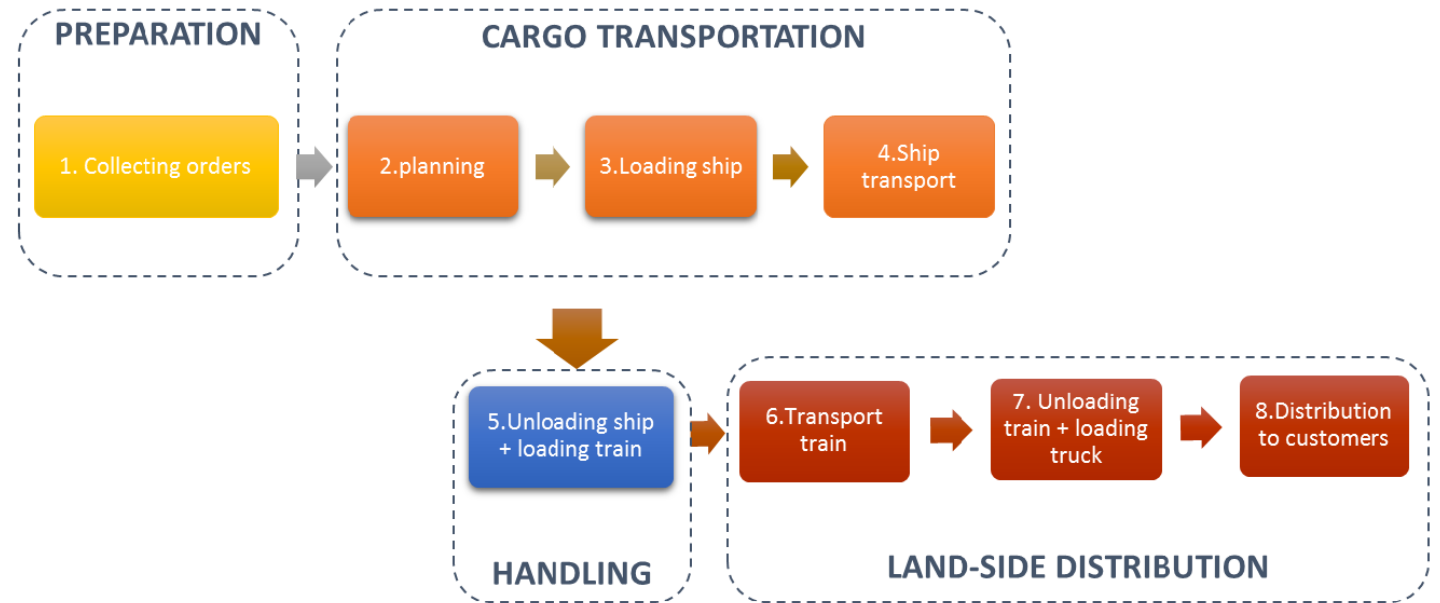
- **Scientific literature review** on data mining/machine learning algorithms/methods on:
 - relevant works approaching issues concerning logistics operations
 - publications related to the identified business use cases
- **Categorization** based on machine learning tasks:
 - classification approaches
 - regression approaches
 - hybrid methods
- **Algorithms and methods:**
 - *Time delay or arrival prediction:*
 - Classification and Regression Trees (CART),
 - Logistic Regression,
 - Support Vector Regression (SVR),
 - Random Forest etc.
 - *Location prediction:*
 - Content-based methods (like Markov model),
 - Distribution-based methods,
 - Pattern-based methods etc.

Literature review of algorithm's evaluation criteria

- **Scientific literature review** on evaluation criteria of the machine learning algorithms
- **Categorization** based on the most common practices of evaluation of machine learning models/tasks:
 - classification
 - regression
 - clustering
- **Criteria and metrics:**
 - *Pearson's, Mathews Correlation coefficient*
 - *Precision, Recall, Accuracy and F-measure*
 - *Receiver Operating Characteristic (ROC) Curve and its Area Under the ROC Curve (AUC)*
 - *Precision – Recall Curve (P-RC) and its Area Under Curve (AUPR)*
 - *(Normalized) Root Mean Square Error (RMSE, NRMSE)*

Available Data

- Ekol Lojistik provided data concerning their freight transshipment operations.
- Describing transportation of orders to/from different customers and destinations in Europe, through trucks, trains and vessels.
- Data exploratory analysis for extracting correlations and useful information.

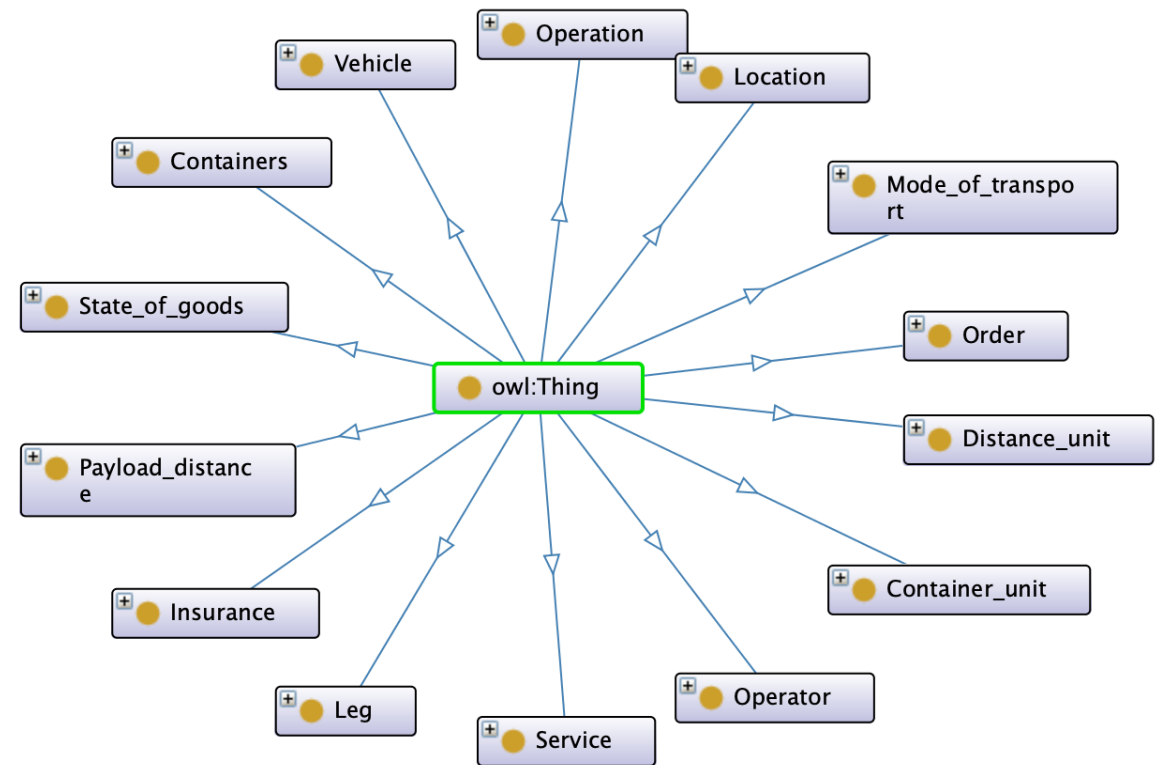


Logistics Ontology for BIG-SMART-LOG

A logistics ontology has been created in order to semantically describe the processes and data related to project use cases

The ontology contains over 100 classes and sub-classes containing major means related to logistics such as:

- Logistic operations and services
- Vehicles and containers
- Transportation modes
- Location and distances
- Orders
- Operators



Framework Architecture

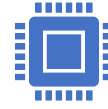


Data Management:
Retrieving and storing data based on following sub-components

Live Data Aggregator:
Sensors, GPS etc.

Database Query Engine: Historical data stored in database and querying mechanisms

Open Data Collector:
Data from public sources



Data Pre-processing: Turn data into a united, compatible form, ready for our main processing



Data Analysis Framework: The "brain" of the whole system

Training Module: Feed existing data to our models and improve their accuracy

Analytics Module:
Exploratory data analysis to reveal hidden insights

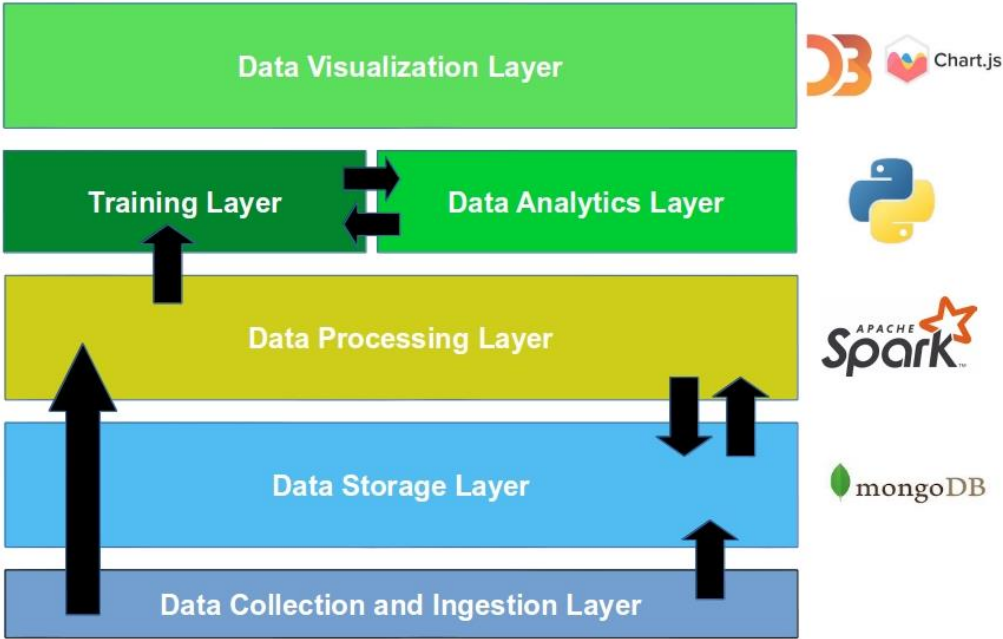


Decision Support:
Suggest decisions and actions, based on the analytics outcome

Optimization Engine:
Help optimize the process, reduce costs, make best choices

Visualization Module:
Visual representations of the data analytics, graphs, plots etc.

High Level BD Visual and Data Analytics tool Architecture

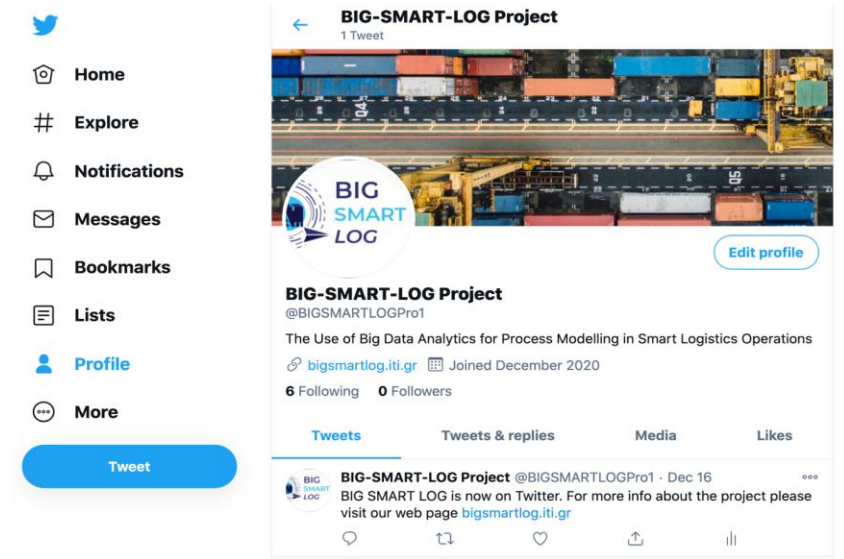


Functional View Diagram

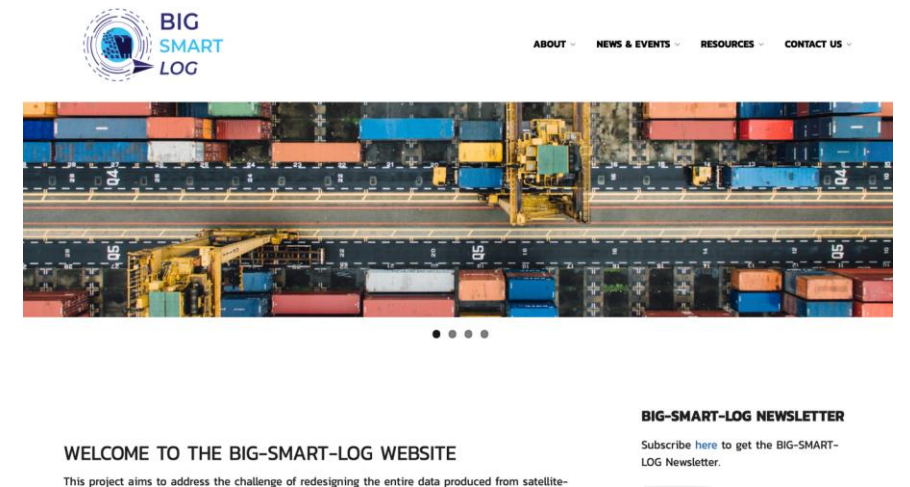


Dissemination

- Continuous dissemination through project's webpage and social media accounts
- Participation in 9 international events
- 14 scientific publications to peer reviewed journals and proceedings of international conferences



Big-Smart-Log Twitter Account



Big-Smart-Log Landing Page

Next Steps

- Implementation and evaluation of methods and algorithms
 - Determining appropriate algorithms according to problem and objective definition
 - Implementing of the machine learning components
 - Evaluating techniques, methods and algorithms
- Development of integrated data analytics web platform

Thank you for your attention

