MAtchUP

D3.22 Urban platform adaptation specifications in Dresden

WP 3, T 3.6.1, T 3.6.3

November 2020 (M38)

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2	Maik Thiele	TUD	14.08.2018
3	Daniel Skaletzki	DRE	20.08.2018
4	Anja Jannack	TUD	21.08.2018
5	Daniel Skaletzki	DRE	31.08.2018
7	Maik Thiele	TUD	3.09.2018
8	Anja Jannack	TUD	5.09.2018
9	Daniel Skaletzki	DRE	10.09.2018
10	Michael Anz	DRE	16.09.2018
11	Anja Jannack	TUD	17.09.2018
12	Pau Arce	UPV	18.09.2018
13	Anja Jannack	TUD	23.09.2018
14	Daniel Skaletzki Anja Jannack Maik Thiele	DRE TUD TUD	25.09.2019
15	Franziska Streidt	DRE	25.06.2020
16	Anja Jannack	TUD	15.07.2020
17	Daniel Skaletzki	DRE	20.08.2020
18	Maik Thiele	TUD	10.09.2020
19	Anja Jannack	TUD	5.10.2020
20	Franziska Streidt	DRE	14.10.2020
21	Daniel Skaletzki	DRE	15.10.2020
22	Anja Jannack	TUD	30.10.2020
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Abbreviations and Acronyms

Acronym	Description
API	Application Programming Interface
CARDO	Geo Information System
CKAN	Comprehensive Knowledge Archive Network
CSW	Catalogue Service for the Web
DCAT	Data Catalogue
DCAT-AP	Data Catalogue Application Profile for data portals in Europe
DCIP	Data Catalogue Interoperability Protocol
DUVA	Information Management System DUVA
EIP	European Innovation Partnership
FME	Feature Manipulation Engine
GDPR	European General Data Protection Regulation
INSPIRE	Infrastructure for SPatial InfoRmation in Europe
IoT	Internet of Things
ISO	International Organization for Standardization
JSON	JavaScript Object Notation
KPI	Key Performance Indicator
SCDMS	Smart City Data Management System
LANs	Local Area Networks
MQTT	Message Queuing Telemetry Transport
NGSI	Next Generation Services Interface
OGC	Open Geospatial Consortium
ODP	Open Data Portal
SCDMS	Smart City Data Management System
SME	Small Medium Enterprise
TLS	Transport Layer Security
UP	Urban Platform

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1 Abstract

This deliverable aims to report on the current state of Urban Platform of Dresden concepts and developments as part of WP3, Task 3.6. This task focus on following issues developing a number of services to improve city operation, decision-making services and citizen engagement. It describes the requirements of the Urban Platform in regard to existing and newly created use case, services and applications as well as new services in Dresden demo site. All described developments under the umbrella of the comprehensive Urban Platform approach leads to specifications.

D3.22 focus on existing systems and further developed applications. However, in general, the following main specification ensuring data integration and interoperability are explained in D3.24 more detailed. The assessment and evaluation of these requirements of Dresden monitoring are outlined in Task 5.1.

All actions from Dresden Demo site are reflected in deliverable D3.14. The Urban Platform IT architecture is ready and prepared to start collecting data from different data source. When the deployment is completed, it will be able to monitor the data flow and exchange processes. Having *enough* data, information is visualized through dashboards or analyze with agreed ICT KPIs. These KPIs extraction is based on the results of WP5, where indicators are studied and a list of proper ICT indicators are proposed and made computable for the MAtchUP project.

As far as the lighthouse cities in the MAtchUP project share similar objectives, this deliverable D3.22 shares a common structure with the analogous deliverables of WP2, which is D2.22, and WP4, which is D4.22. Furthermore, the first version of this deliverable was presented in M12 and a second version in M24. Therefore, this document is an extended and final version, which additionally explains the new developments and services related to urban platform that have been achieved up to now.

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2 Introduction

2.1 Objective

Within Dresden demo site (WP3) the aim of the implementation of the Urban Platform is developing a number of services to improve city operation, decision-making services and citizen engagement to ensure the interaction between the city of Dresden and its citizens. All these developments will follow the same principles: as much open data as possible, interoperability through open API (open Application Programming Interface) developments and assessing the evaluation process by considering the requirements of the Dresden monitoring plan outlined in Task 5.1.

This deliverable mainly addresses Subtask 3.6.1 Urban Platform adaptations and Subtask 3.6.2 New Services on top of the Urban Platform. Subtask 3.6.1 Urban Platform adaptations, is defined to the open-specifications concept, which will carry out the adaptations required for complying with the open data specifications, as well as open APIs. In this sense, open data gateways will be integrated in the Dresden Urban Platform in order to feed the urban platform with data from the multiple available resources. Subtask 3.6.2 New Services on top of the Urban Platform. Some new services will be developed on top of the Urban Platform in this subtask. This first description of the Urban Platform adaptations and new services of Dresden's platform assures open data interoperability, as well as open APIs. The document will assure that Dresden's platform will be fed with data from multiple variable resources following open data specifications.

The objective of this deliverable is to report on the characteristics that the Urban Platform of Dresden is going to adapt in line with open data strategies, open APIs, and data integration requirements. In the context of MAtchUP, the requirements of the urban platform must be specified, considering the Dresden demo site actions, interventions and the overall objectives of the project. These have to be carried out within the main issues of MAtchUP: Mobility, Energy, and ICT, but concerning the Non-Technical Actions facing economic and social aspects as well. Reference architectures for urban platforms as well as related European urban projects were taken into account.

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2.2 Contribution of partners

The following Table 1 depicts the main contributions from participant partners in the development of this deliverable.

Participant short name	Contributions
TUD	Content development
DRE	Content development and additional information
EASD	Comments on related issues (mainly Energy Data Integration and visualisation)
DWG	Comments on related issues (mainly Energy Data Management)
FhG	Comments on related issues (mainly Mobility aspects)
SAM	Reviewer

Table 1. Contribution of partners

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3 Requirements of the Urban Platform

An Urban Platform (UP) exploits modern digital technologies to bring together and integrate data flows within and across city systems and make data (re)sources accessible to participants in the cities' ecosystem.

The requirements and specifications of an Urban Platform stand at the core of understanding and start of development of a smart city platform. This chapter describes more detailed the urban platforms that are developed by each of the Lighthouse cities in the MAtchUP project. Firstly, the needed specifications of an urban platform are depicted. Secondly, conceptual and technical platform architecture is described, and thirdly other European projects related to the development of Urban Platforms are shortly listed.

Figure 3.1: Word Cloud – Urban Platform

3.1 Specifications of the Urban Platform

All Lighthouse City Urban Platforms are having similar specifications, because they face common challenges of Smart Cities. The three Urban Platforms have comparable main components are and common specifications. They share common features and elements as needs, demands, citizens, services, or IoT devices. At the same time, each city has its very own particularities, and individual specifications owing to its contexts including technological, legal, social and economic constraints differ. For example, a city can decide whether information on waste management is collected in real-time, in which case the way to collect and process the information would be different technologically speaking.

The following common specifications belong to all three Urban Platforms:

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- *Big Data* refers to the distributed storage of a huge amount of data that can be accessed in a reliable way, but also it is related to functions and processes to analyse pieces of data as quick as possible, obtaining analytics, statistics or indicators.
- *Context Broker* enables publication of context information by entities, referred as context producers, so that published context information becomes available to other entities, referred as context consumers or sinks, which are interested in processing the published context information.
- *Dashboards* are the easiest way of representing all the data stored and processed in the urban platform. Using panels and graphs, city administrators or citizens can keep up with anything that the city is monitoring. The use of maps is another way of showing georeferenced information, enhancing the comprehension of data.
- *IoT Devices* involve all sensors and devices that collect information from the city or the environment and are able to send that measurements to the urban platform.
- *Open (DATA) Portal* involves the publication of those data that can be considered of public interest, improving government transparency and making datasets available for citizens, entrepreneurs or third parties that can take advantage of these functions to improve the social and business network.
- *Security* is an important piece of any urban platform, which may require mechanisms of authentication to ensure the correct operation of the platform.

3.2 City Urban Platform

In this section, Dresden Urban Platform is described in detail, regarding its adaptation and specifications approaches. For the other two lighthouse cities within MAtchUP project, the reference Deliverable to D3.22 are named.

3.2.1 Valencia Urban Platform

The Valencia demo site describes its UP in deliverable D2.22.

3.2.2 Dresden Urban Platform

3.2.2.1 Reference architecture

There are several well-known reference architectures for Urban Platforms such as the Reference Architecture Model "Open Urban Platform" (OUP) DIN SPEC 91357 [1] as well as architectures, which are part of existing frameworks like EIP (European Innovation Partnership) [2], ITU-T (International Telecommunication Union) [3] and ESPRESSO [4]. Beside the different surface forms and descriptions, all the reference architectures have a lot in common and follow the same ideas. The most important insights of these works are the following:

- ✔ Sensing devices need to be deployed throughout the city in order to monitor multiple parameters.
- ✔ Data acquisition and information gathering should rely on open and standard protocols.

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- ✔ Interoperability aspects with the objective of providing open APIs, open Data and open SDKs need to be considered.
- ✔ Data storage, implementation of analytics and data management are core modules within an Urban Platform.
- ✔ Calculation of indicators gives support to decision-making tools for the city stakeholders and are important to present useful information.

3.2.2.2 Urban Platform Objectives and Comprehensive Approach – content view

The Urban Platform is an intellectual and logical approach to connect existing and future IT systems of the state capital Dresden as well as data gained by the local MAtchUP project partners. The systems involved not only are aware of each other, and exchange data, moreover they use their logical and analytical abilities in interactive processes to prepare decision-making and atomize processes. The prerequisites for the implementation of this logical approach are the use of state-of-the-art technologies and infrastructures, standards and services (technical services) as well as data and applications (apps). The aim is to improve the available infrastructure data in Dresden, to develop new applications on this basis and to give third parties the opportunity to create new business models on the basis of data in the city. The cross-office use of data is also improved.

To this end, MAtchUP will implement a targeted selection of practical applications for the Urban Platform and establish standards for the future. With regard to these standards, there is not only a need from a technical point of view, but increasingly also for conceptual standards. An urban platform is not only about the technical networking of the systems, but primarily about content and knowledge-based networking on a technical level. But building up knowledge requires the passing on of information, which in turn requires a technically understandable exchange of data. To make this data interchangeable, analysable and interpretable, conceptual standard must be created as a prerequisite for constantly increasing data collection. The quality and quantity of services available within the Urban Platform have a decisive influence on the digital intelligence quotient of a Smart City. According to the European definition, the urban platform should:

- ✔ Cater for interoperability between urban infrastructures
- ✔ Enable replicability of the solutions/platforms city to city
- ✔ Scale without technical constraints and excessive cost increase
- ✔ Provide open APIs
- ✔ Enable Real Time capabilities
- ✔ Support implementation of functional and technical capabilities

The Municipality of Dresden, in line with its Digital Agenda, has developed a comprehensive ICT-Infrastructure in which many vertical services of the city are integrated by now. This Urban Platform of Dresden is in charge of gathering information from several municipal services in order to provide information for decision-making within the city of Dresden. Furthermore, the existing set of key indicators to support this decision processes needs to be elaborated. Another objective of the

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platform is to offer data to the citizens and municipal managers to support all the necessary information to ease their daily life.

The following vertical services are to be integrated and managed through this platform:

- ✔ Water: data gathered and local water managed services deployed
- ✔ Traffic: maps and status integrated (e.g. parking space, online ticket purchasing and construction sites)
- ✔ City dashboard
- ✔ Charging infrastructure information
- ✔ Mobility app for public transport
- ✔ Open Data Platform
- ✔ eGovernment
- ✔ Energy Management in Municipal buildings
- ✔ Citizens' portal

The Smart City strategy of Dresden found its place in the guiding strategic planning documents approved by the city council and discussed with citizens in the course of the planning process. According to the IDC Smart City [5], it encompasses processes that are based on the involvement of information and communication technologies and further technologies to support urban organisation and development. The networked and intelligent infrastructure serves to improve competitiveness of the local economy, resource efficiency, strengthens the participation of citizens and helps to integrate social aspects.

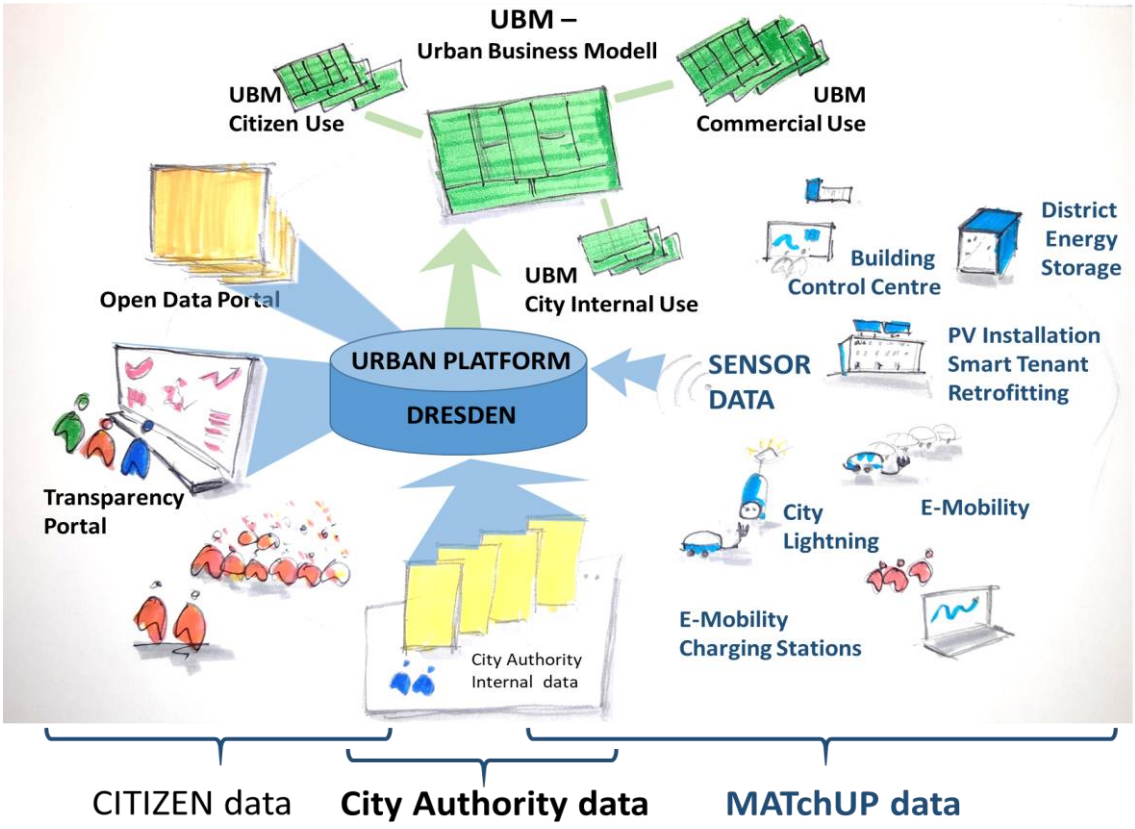

Figure 3.2: Dresden Urban Platform – content view

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This allows citizens being part of a wider network and allows for social integration, enables participation in the knowledge society and fosters thus a higher quality of urban life. The competences within the city in the fields of building, mobility, energy and government as well as security need to be enhanced.

The local Urban Platform was further developed and more services derived from the needs of different stakeholders as for instance municipality, citizens, or companies. By now, several applications exist and are processed by the Urban Platform, but the UP lacked an overall concept on how to combine data collection and making the most use out of the data so far. Within MAtchUP, it has been further developed the existing platform systems towards a central data hub used for social, administrative, and as well for commercial purposes. As a first step, an overall picture was depicted in order to derive a comprehensive logic for the further technical development, the professional and conceptual perspective was aggregated in Figure 3.2.

The Smart City strategy of Dresden is firmly anchored in the strategic planning guidelines that were approved by the city council after a participatory planning process that also involved the citizenry of Dresden. According to the IDC Smart City [4], it encompasses processes that are based on ICT and other technologies to support urban organisation and development.

As a vision, networked and intelligent infrastructures are to improve the competitiveness of the local economy, enhance resource efficiency, strengthen the participation of citizens and integrate multiple social aspects. As a major aim, citizens need to be empowered as members of a wider stakeholder network, in order to enable better social integration, participation in the knowledge society and eventually a higher quality of urban life. Within MAtchUP several existing UP applications Themenstadtplan [6], or Open Data Portal [7] (see D.3.24), and systems such as DUVA or KomissDD (see Chapter 3.2.2.3.1 /3.2.2.3.2) were further developed in order to form a central data hub that can be used for social, administrative, and as well for commercial purposes. In the co-creation process, a number of new services was derived from the needs of different stakeholders as municipality, citizens, or companies.

The first step was to create an overall picture in order to derive a comprehensive logic for further technical development, and to aggregate the different professional and conceptual perspectives. Figure 3.2 illustrates the underlying concept on how the integration of different data sources may lead to new services, here named Urban Business Models (UBM). The potential applications were clustered into three categories:

1) Urban administration
2) Citizens
3) Business (existing and new)

Therefore, all the Dresden Actions (see D3.14) are feeding data into the Urban Platform in either one-to-one or in an aggregated manner.

Data provided by MAtchUP Actions, which depict on the right side of Figure 3.2, termed MAtchUP Data. Moreover, data of the city council itself may be considered to be processed by the Urban Platform later on as well as citizens' data and data collection

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through citizens will be assessed in future applications of the Urban Platform. Therefore, investigations in useful data and application scenarios will be pursued as a continuous process. By now, the MAtchUP actions played a double role: they contribute with data to the platform and make most use of this.

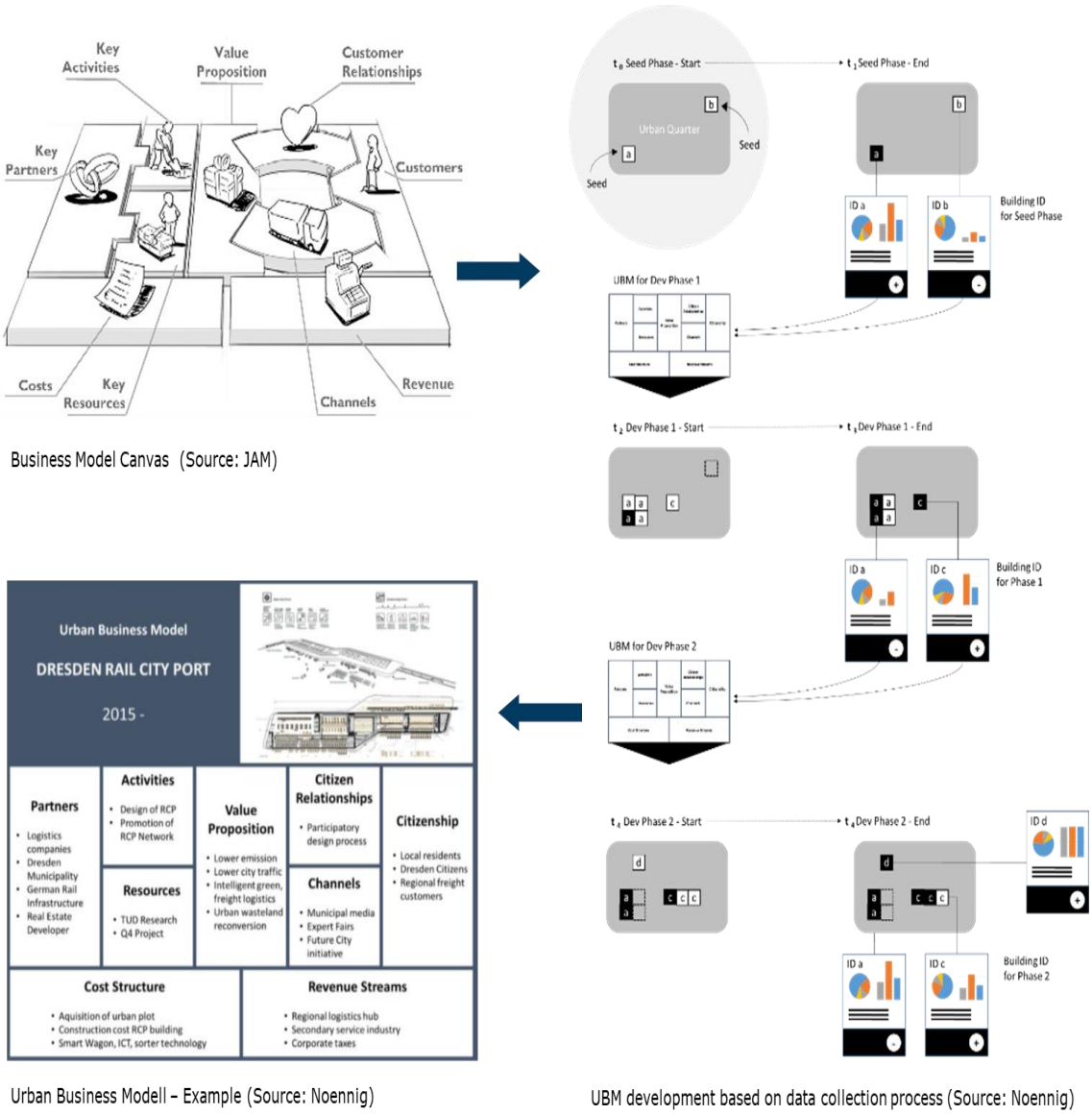

Figure 3.3: Urban Business Modell Approach

The method of Business Model Creation was established in the field of economics to help start-ups validate their business strategy and operational design. This methodology was translated by its originators into a popular tool called Business Model Canvas [8] providing a structured and synoptic overview of all key parameters in business plans with an easy-to-use table template structure.

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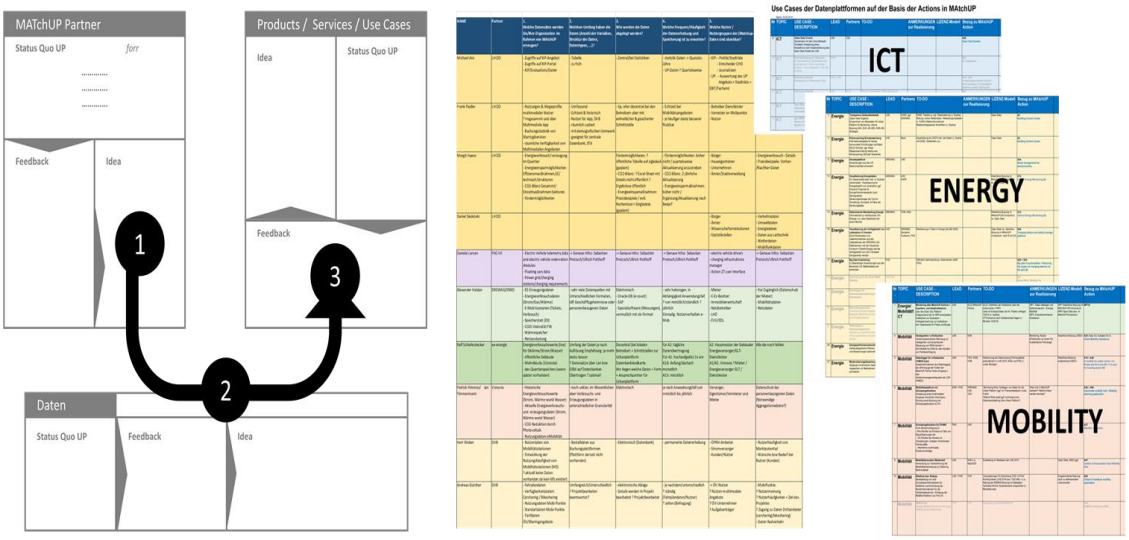

Figure 3.4: Urban Business Modell Approach - Adaptation to MAtchUP Dresden UP

By interpreting its components from urbanist and IT perspective, we can translate this method of Business Model Creation to the context of urban development and urban management. Given that few instruments allow for the comprehensive description of urban operations in economic terms, all key components of the Business Model Canvas can be analogically identified within those larger enterprises called 'cities', leading to what can be called 'Urban Business Models' (UBM). The UM approach shown in Figure 3.4, was designed by TUD Knowledge Architecture Lab, and applied in MATchUP see in Figure 3.5 to generate use cases for the UP within the Smart City context, specifically in the co-design and further development of the Urban Platform.

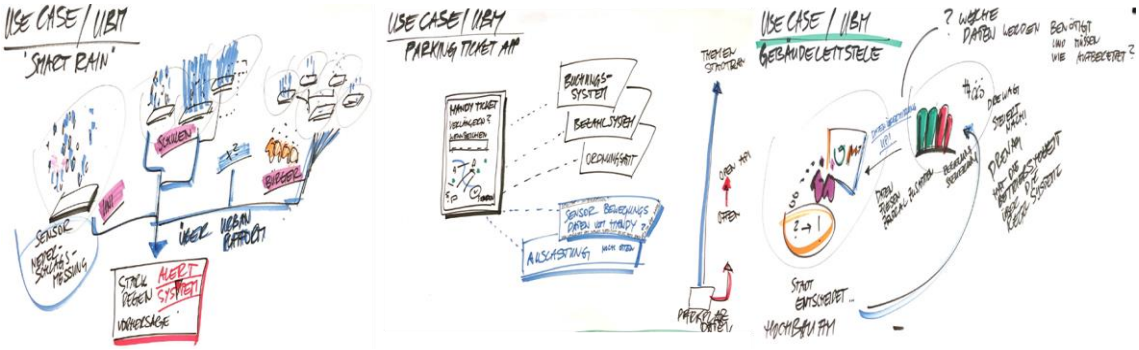

Figure 3.5: Urban Platform **-** Use Case visual graphs

To better describe and create new Use Case, several Use Case workshops with different stakeholder perspectives were carried out during the last 36 months. Within these, one aim was to depict the content view of the Use Cases in visual graphs (see Figure 3.5). Moreover, a Data Collection of current and future Use Cases of the UP was started in an excel database (see Figure 3.6).

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Nr.	Thema	Beschreibung	Lead	Partner
1	**Mobilität**	**E-Parkschein/ Handyparken** Elektronischer Parkschein ermöglicht bargeldlose Bezahlung.	LHD	DVB
1	**Mobilität**	**Installation von Datenloggern zur Datenerhebung** Informationen aus Datenlogging der eFahrzeuge der Flotten der MAtchUP-Partner finden Eingang in das Verkehrsmanagementsystem der LHD VAMOS	LHD	FHG DWG VON
2	**Mobilität**	**Einrichtung einer Mobilitätsplattform durch DVB** Umsetzung eines multimodalen Ansatzes hinsichtlich aktueller Information, optimiertes Routing und Push Benachrichtigung bei Verkehrsbehinderungen.	DVB	LHD (Amt 66) DREWAG FHG, TUD
3	**Mobilität**	**BikeNow App** Daten von Radfahrern werden erhoben, analysiert und auf dieser Basis werden optimierte Routenführung erstellt, und Grünphasen angepasst	LHD FHG	TUD
4	**Energie**	**Integration eines Energiemanagementsystem --> cENtERGY** Anwendungen zur Erfassung und Aufbereitung der LIS Elektromobilitätsdaten und verschiedener Sensordaten. Übertragung von (Echtzeit-) Sensordaten ins cENtERGY, wo die Daten aufbereitet und zur weiteren Verwendung weitergegeben werden.	DREWAG	LHD
5	**Energie**	**Einrichtung einer Zentralen Gebäudeleitstelle** Einsammeln von Messdaten für Urban Platform, Monitoring, interne Nutzung, sowie Klima-Coaching: Informationsangebot für Nutzer kommunaler Einrichtungen auf Basis ZGLS (Schulen, ggf. Kitas) Wissensvermittlung Heizkurven, Klimacoaching	LHD	EASD DREWAG
6	**Energie**	**Anpassung der Anlagenregelung an den tatsächlichen Bedarf** Optimierung von Energiesystemen unter Berücksichtigung des aktuellen Energieverbrauchs. Zukünftig soll über Automationssysteme optimierend in die Anlagenregelung von Einzelgebäuden eingegriffen werden können. (Zentrale Gebäudeleitstelle)	LHD	Amt 65 EASD
7	**Energie**	**Elektronische Informationstafel Energie** Informationen zu Verbräuchen (PV, Energie u.a.) über Dashboard auf einem Monitor	DREWAG	VON WGJ
8	**Energie**	**SmartLighting (Beleuchtungsmonitor)** Prüfen des Einsatzes von Adaptiven Beleuchtung hinsichtlich Zeit und Energieeinsatzes.	LHD	DREWAG FHG
9	**ICT**	**Open Data Portal der LHD** Bereitstellung von städtischen Daten für interessierte Bürgerinnen und Bürger sowie für Wirtschaftsunternehmen und Startups vorsieht. Alle Datensätze stehen in einem standardisierten, maschinell abrufbaren Format zur Verfügung. Sie können kostenlos genutzt werden.	LHD	TUD
10	**ICT**	**Upgrade Open Data Portal der LHD** Layoutanpassungen Integration eines MAtchUP Testmandanten, sowie eines Mandanten für Darstellung der MAtchUP-Daten Datentransport sicherstellen und automatisieren / Anforderungen für Folgeprojekt definieren	LHD	
11	**ICT**	**Datenbereitstellung für nicht-kommerzielle/wissenschaftliche Zwecke** Bereitstellung verschiedener Daten zu Bildungs-und Forschungszwecken. (Klimacoaching) Schüler, Leher und Mitarbeiter von Bildungseinrichtungen werden perspektivisch Zugriff auf verschiedene Umwelt- und Energiedaten ihrer Gebäude haben, um Analysen und Auswertungen durchzuführen, mit dem Ziel eine erhöhte Sensibiltät für Themen Nachhaltigkeit und Energieeffizienz zu erreichen.	LHD	externe Partner
12	**ICT**	**Open Data Camp** Open data Camp wurde am 9./10.November durchgeführt. Die Veranstaltung bietet die Möglichkeit nützliche, kreative oder unterhaltsame Softwareprodukte, basierend auf offenen Daten, herzustellen. In Teams wird selbstorganisiert innerhalb einer festgelegten Zeit ein Konzept bzw. ein Prototyp erarbeitet. Am Ende der Veranstaltung stellen die Teams ihre Ergebnisse einer Jury vor.	LHD	TUD
13	**ICT**	**SMART RAIN** **Regensensoren installieren.** Sensorinformation erheben und nutzbar machen. Daten fließen künftig in cENtERGY ein.	LHD	TUD
14	**Energie** **ICT**	**Visualisierungstool zur Darstellung von Energiedaten** Graphische Darstellung in Form eines City Dashboatrd, wo Energiedaten wie Energieverbrauch, Ladestationen- / Parkplatzverfügbarkeit, stadtgebietweite Nutzung von Car- und Bikesharing Service in Echtzeit dargestellt ist	DREWAG	LHD EADS
15	**Energie** **Mobilität** **ICT**	**Monitoring aller MAtchUP-Actions und KPIs** Entwicklung von Berechnungsmodellen zur Identifizierung und Evaluierung von KPIs. (Mobility, Energy, ICT) Ziel ist die Vergleichbarkeit unter Partnerstädten und die Evaluierung des Projektfortschritts. Monitoring beginnt ab April 2020.	LHD	alle
16	**Energie** **Mobilität** **ICT**	**Integration von Energieverbrauchsdaten in den Themenstadtplan** Spezifische Energieverbräuche (z.B. kWh/m²*a) der Gebäude können durch Einfärbung (grün, gelb, rot) auf einer Karte klassifiziert und für die Bürger einfach verständlich dargestellt werden.	LHD	Amt 80 Amt 62 TUD

Figure 3.6: Dresden Urban Platform – Use case: Interventions and Adaptation

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3.2.2.3 Urban Platform Description - technical view

The Urban Platform, as the main tool for implementing the Smart City strategy of the city of Dresden, was further developed based on the IT architecture shown in Figure 3.7. The technical view represents the services, applications and core features existing in the several back-end databases. The interconnection and implementation plan within MAtchUP is to enhance interoperability and ensure scalability of the UP.

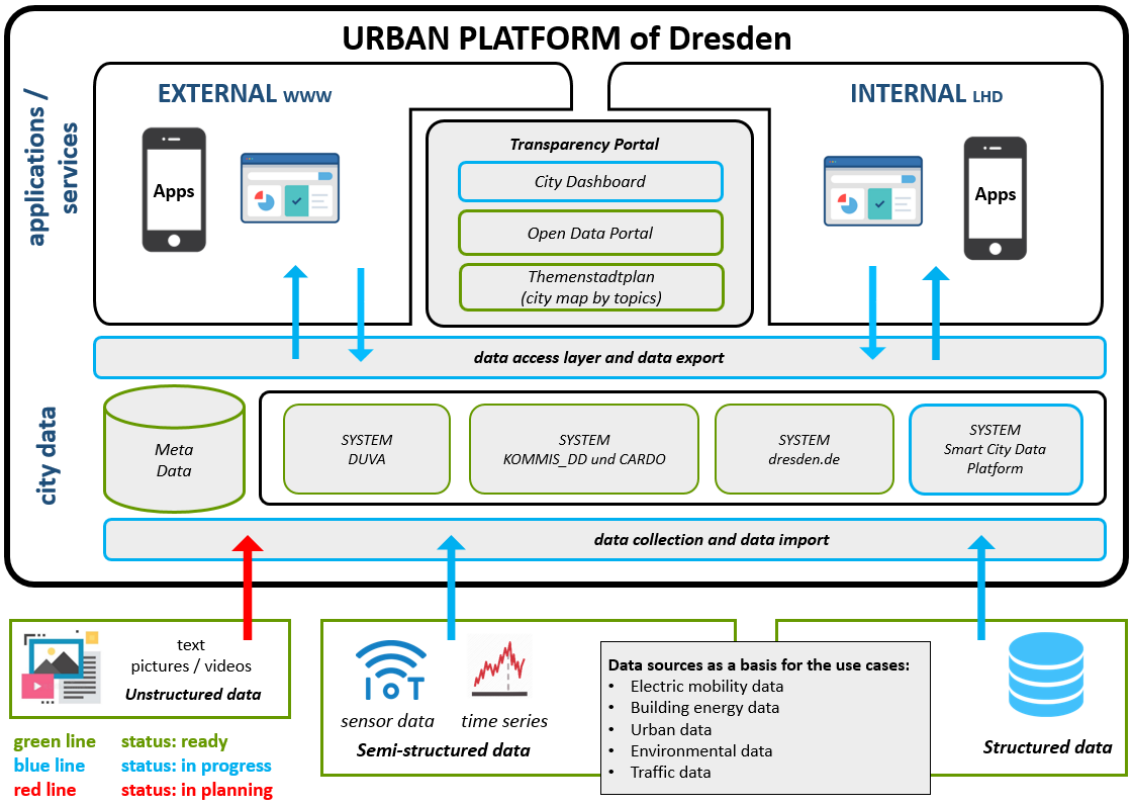

Figure 3.7: Technical view of the Dresden Urban Platform

The municipality of Dresden moved its physical (hardware) infrastructure to a new data centre where the backbone has been extended with various servers, benefitting from the opportunity to process higher data volumes there. This also leads to lower latency times, and increased systems efficiency mainly for improving real-time or near real-time connection to urban objects.

Moreover, significant progress in the establishment of a common WLAN infrastructure among the city and municipal companies like DVB (Dresdner Verkehrs Betriebe) has been made. Different technologies are used to establish the following services:

- ✓ Authentication: Microsoft Active Directory,
- ✓ API development e.g. through JAVA, IoT/M2M
- ✓ Data Sourcing: using web services,
- ✓ Data visualization tools: e.g. dashboards, ESRI tool (using Angular, Grafana, etc.).

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The main systems for storing the relevant data for the Urban Platform are:

- ✓ Information Management System DUVA
- ✓ Geo Information System KOMMIS_DD and CARDO
- ✓ Backend System dresden.de
- ✓ Smart City Data Management System

3.2.2.3.1 Information Management System DUVA

3.2.2.3.1.1 DUVA approach

Data are placeholders for complex information. The perfect means of indexing Information is the language. Via a linguistic description of dates and backgrounds the data on information and comprehensible knowledge can be understood and made accessible and transparent.

The KOSIS community DUVA pursues with its information management system the approach, the handling of information and technical procedures via the medium of speech. In this process, data is transmitted down to the level of individual characteristics and processing routines described in terms of content. In addition, there are background information such as the chronological validity, the spatial reference, information on the origin the data or definitions of terms. Data and the corresponding linguistic descriptions are firmly linked to each other; should data or processing routines be searched for or applied, the search is carried out and the call exclusively via the existing linguistic descriptions. The stock of metadata thus built up is stored together with the associated data in central databases management. The principle here is freedom from redundancy: every description is only created once. If the contents are to be data or procedures described will simply be added to the already existing description and a corresponding Shortcut created. Language descriptions once created can be used extensively: If information in the form of tables, graphics or cards are evaluated, the output is automatic with the appropriate inscriptions and legends.

From the description of a file, you are linked to a labelled registration form via which new data can be entered directly into the DUVA system. When entering new data, the link to the appropriate linguistic descriptions is done automatically. Descriptions can be exported and used elsewhere for work with data of the same content, and can be imported as well.

3.2.2.3.1.1 Overview of the DUVA system

DUVA comprises a system of integrated individual applications each with specific tasks. From acquisition to processing with all the several work steps of t information management is covered. The detection system serves as the administration and processing of the existing information. In this detection system, calculations, aggregations and operations, other than productions, can be carried out. For the processing of these operations the Target File Generator module, that is triggered from

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the detection system, is responsible. The detection system will also feed files from external sources into the DUVA system. As file selection of the internet assistant, DUVA developed its own web-based application for disposal. With it, the entire metadata stock of the DUVA system can be researched. Selected files are then sent to the Internet Assistant, where they are analysed and presented in the form of diagrams, tables and thematic maps.

For the production of thematic maps it has its own web-based application. It, is asked by the Internet assistant and supplied with the necessary data. This corresponds to the current OGC and INSPIRE standards (see D3.24). Extensive possibilities are available for map design. The created tables, diagrams and maps can be directly into other applications (e.g. word processing systems) can be exported.

Parts of the applications are provided by DUVA in the information portal. With it information can provided in the form of tables, diagrams, maps etc. and offered in a structured way in the Internet and so been made openly available. Thus a portal is available, through which interested Citizens, policy makers and other interested persons can independently research on information. For the data input, DUVA provides suitable applications already. With this new, freely configurable, applications can be generated, completely in line and integrated with the material- and metadata flow of the DUVA system . Via this the data on the PC or via the web can be directly entered into the DUVA system. The DUVA system provides integrates export and import options. Information can be exchanged directly between users.

Figure 3.8: uses modules from DUVA for MAtchUP project

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All factual and metadata are stored in common server databases. Newly created Factual and metadata flow automatically into these databases and are available there for further work steps available. The content integration on a common language for metadata finds its counterpart in technical integration of the work process.

DUVA has an application for individual Administration of user and system settings. The DUVA applications can switched to use in other languages.

3.2.2.3.2 Geo Information System KOMMIS_DD and CARDO

The state capital of Dresden uses following software components to implement the uniform geo data infrastructure:

- ✔ the municipal meta information system (KOMMIS_DD) which is in operation since July 2008
- ✔ the central geodata database (OracleSDE)
- ✔ the unified geographic information system ArcGIS
- ✔ the geodata portals Cardo and Themenstadtplan [6]

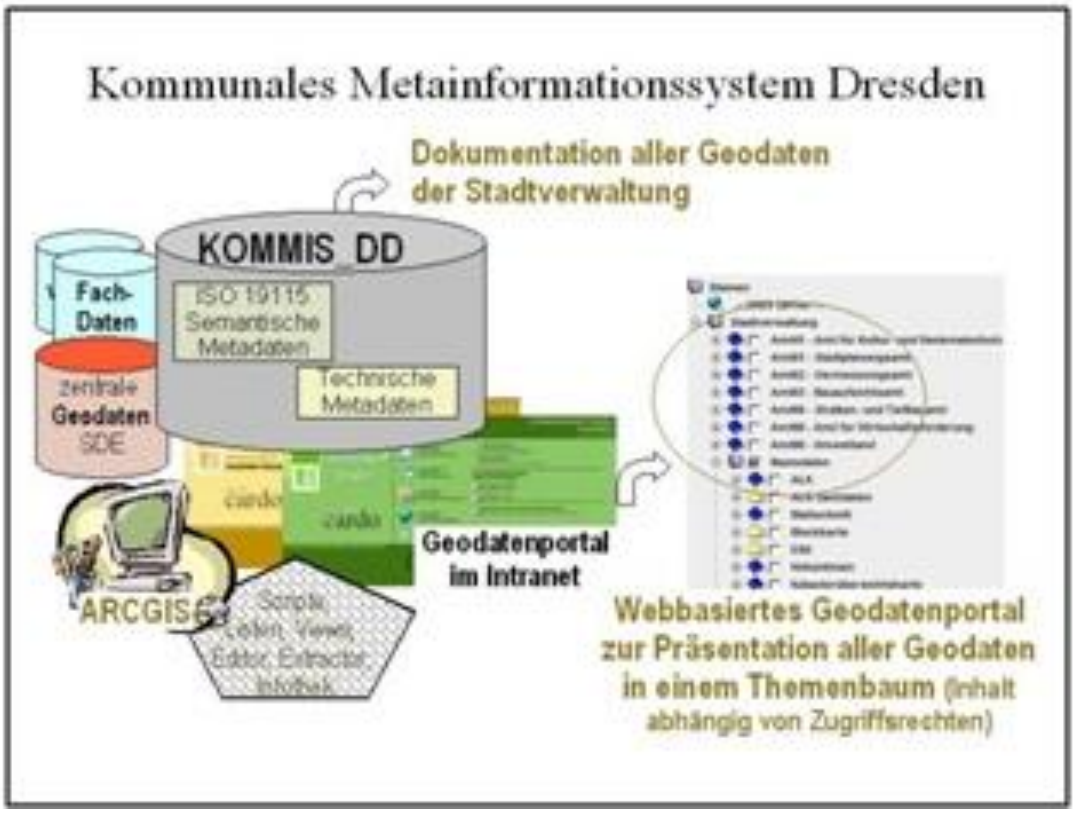

Figure 3.9: Municipal Meta Information System Dresden

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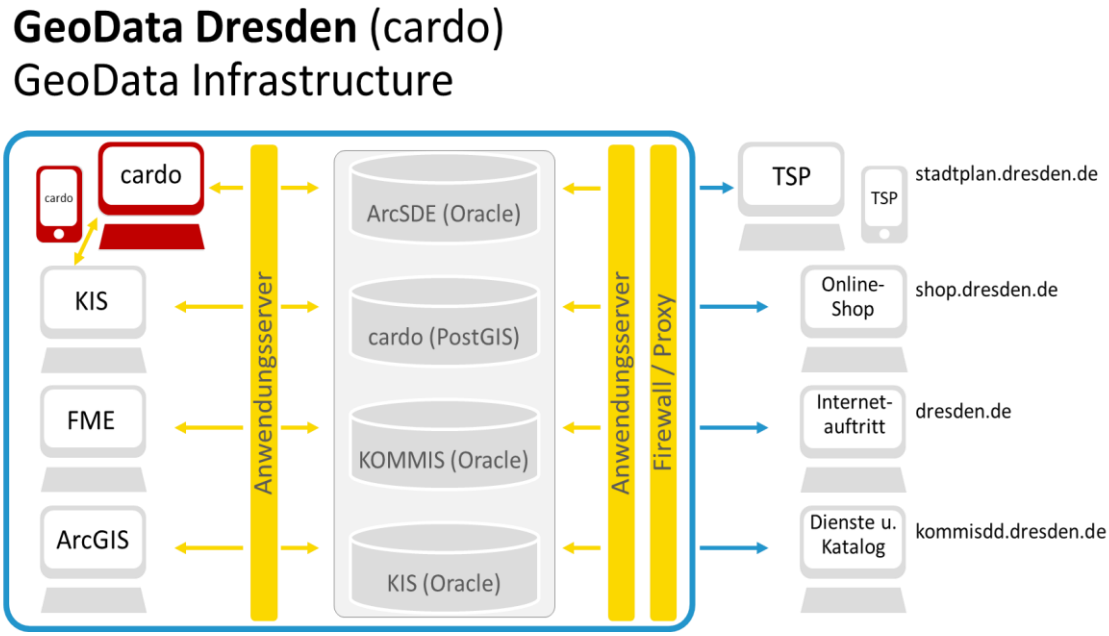

Figure 3.10: GeoData Infrastructure (cardo) Dresden

All datasets, which are part of the geodata portal CARDO, are centrally registered and described in KOMMIS_DD. KOMMIS_DD is based on a dynamic data model. Besides descriptive data, it contains also technical metadata and lookup lists. KOMMIS_DD fulfils the following functions:

- ✔ Controlling the visualization of geodata in the geodata portals (permissions, availability, etc.)
- ✔ Central overview and documentation of data sources content and their applications
- ✔ Provision of metadata services in the form of OGC-compliant Catalogue Service for the Web (CSW), documents for external portals, e.g. in the environmental data catalogue or GeoMIS Saxony

3.2.2.3.3 Backend System dresden.de

With the Internet portal dresden.de, all public information of the state capital from different offices as well as municipal institutions from culture, sports etc. are made available for the inhabitants. The Themenstadtplan [6] (city theme map) is a map-centric web application that allows visualization of data with geo references in a user-friendly manner.

There is a very comprehensive list of several hundred topics available. This web portal is equipped with an API, which can be used for example with the CKAN GeoMISHarvester. Furthermore, links to the MapControl can be integrated into the corresponding CKAN data record.

The data is stored centrally in a database (Oracle) with separation by individual clients depending on the application case. It is possible to connect further data sources to the

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system at any time. The entire layout of the website was completely revised in 2015 and is directly managed by DRE (previously external service). The individual applications are captured in apps depending on these specifics. The development of the front-end is done using Java Wicket. Open interfaces for the transfer of data to internal and external systems are under development. Regarding the actual data basis, the corresponding authorization concept must still be agreed with the technical office in charge.

3.2.2.3.4 Smart City Data Management System (SCDMS)

The Smart City Data Management System SCDMS is a software solution that helps and supports the city of Dresden to keep Smart City data and to establish and maintain energy management, also in compliance with certification requirements (see Figure 3.11). Based on the acquisition of energy measurements of any time series (energy data: electricity, gas, water; environmental data, mobility data).

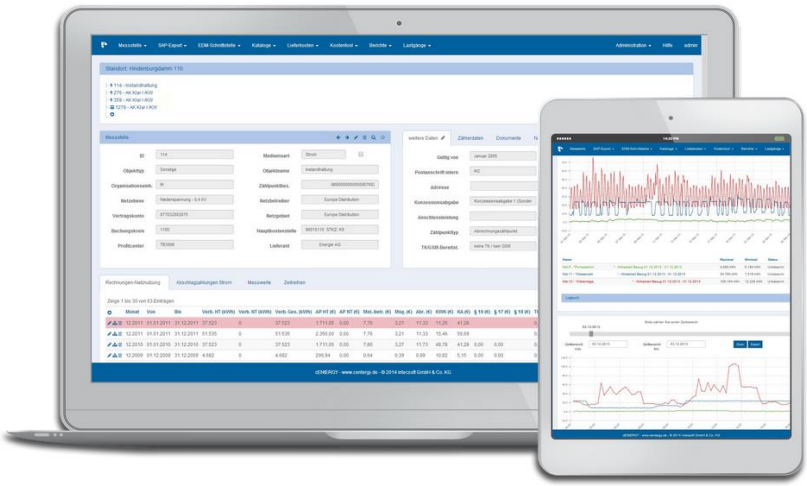

Figure 3.11: Smart City Data -Management-System - to collect and process Sensor-Data

Among other things, measuring points can be arranged in a structure of objects, which allows complex municipal structures and buildings to be mapped in the system.

Furthermore, it offers the possibility to serve as a central data hub for consumption and sensor data with the aim of providing and forwarding / processing data to other systems and applications. The aim of the project is to create a technologically modern, uniform and comprehensive solution for the development of neighbourhoods in the Smart City environment, which combines own generation, mobility, technical and energy aspects in a web-based application.

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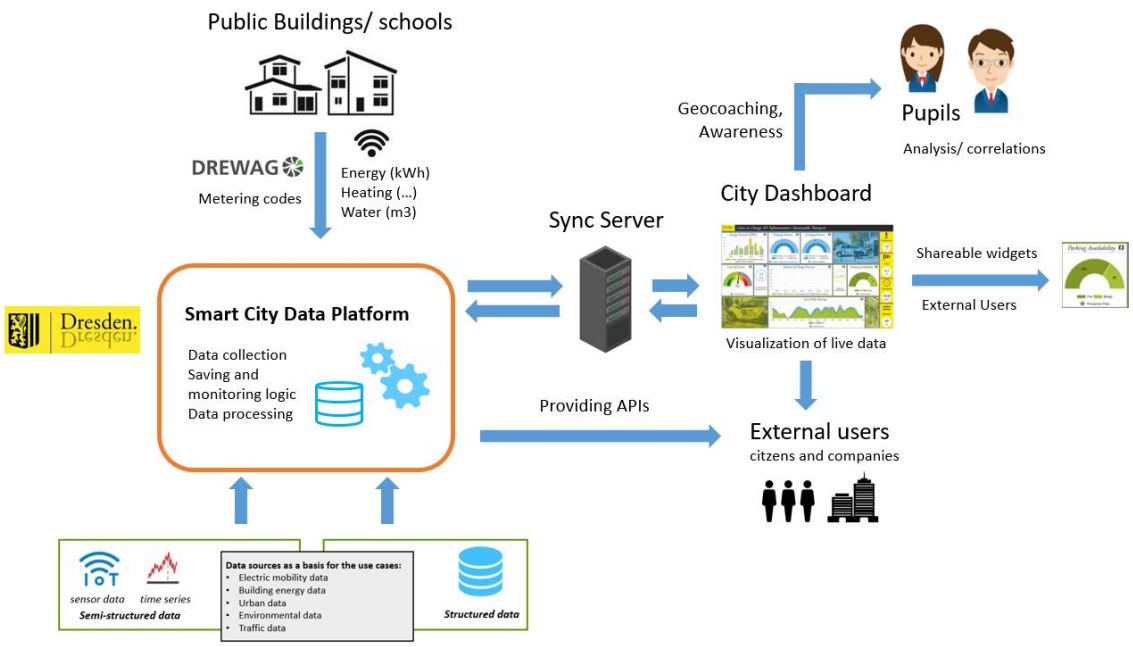

Figure 3.12: data flow with the Smart City Data Platform

For this purpose, SCDMS is to be integrated into the city of Dresden with the aim of providing, passing on and processing the above-mentioned data for and to other systems and applications. In particular, the integration of the time series database influx DB offers a technological leap forward that will enable the efficient and fast provision of data. A further goal is the creation of the basis and development of an ISO-50001 compliant energy management system. This is already obligatory for non-SMEs and can be expected in the near future for municipal sectors.

3.2.3 Antalya Urban Platform

The Antalya Urban platform is described in deliverable D4.22.

3.3 Related European Urban Platforms

In this section, shortly refers to other European projects whose purpose is or has been to define, propose or implement a smart city platform architecture.

The vision behind most of the platforms, is the business and technology design, the implementation barriers and accelerators, and the usage and for data management of urban data among European smart cities.

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Figure 3.13: Smart Cities and Community Projects

DataPorts A Data Platform for the Cognitive Ports of the Future

Grant agreement ID: 871493

Status Ongoing project

Start date 1 January 2020

End date 31 December 2022

Hundreds of different European seaports collaborate with each other, exchanging different digital data from several data sources. However, to achieve efficient collaboration and benefit from AI-based technology, a new integrating environment is needed. The EU-funded DataPorts project will design an Industrial Data Platform. The Cognitive Ports Data Platform will connect existing digital infrastructures of seaports and their systems, will set rules on safe and reliable data sharing and trading, and offer powerful services of data analytics. That will allow to create different smart applications according to related requirements. Before full implementation in European ports, the platform will be implemented in two European seaports. The platform will make European seaports trusted, strong and integrated.

DataPorts will boost the transition of European seaports from connected and digital

to smart and cognitive. By providing a secure environment for the aggregation and integration of data coming from the several data sources existing in the digital ports and owned by different stakeholders, the whole port community could get real value from this data in order to improve their processes, offer new services and devise new AI based and data driven business models. DataPorts will design, implement and operate an Industrial Data Platform (Cognitive Ports Data Platform). So that:

- connects to the different digital infrastructures currently existing in digital seaports, enabling the interconnection of a wide variety of systems into a tightly integrated ecosystem;
- ii) sets the policies for a trusted and reliable data sharing and trading based on data owner's rules and offering a clear value proposition; and
- iii) leverages on the data collected to provide advanced Data Analytic services based on which the different actors in the port value chain could develop novel AI and cognitive applications.

DataPorts project involves the design and implementation of the platform, its deployment in two relevant European seaports. Via connecting their existing digital infrastructures and addressing to specific local constraints, a global use case - involving these two ports and other actors and targeting inter-port objectives -, and all the actions to foster the adoption of the platform at European level. This project will imply that tools, platforms and systems running in the different seaports all across Europe will benefit from the DataPorts industrial data platform, in order to create an even more trusted, reliable and efficient way of conducting businesses in Europe and to reinforce the European Single Market.

mySMARTLife Smart Transition of EU cities towards a new concept of smart Life and Economy

Grant agreement ID: 731297

https://www.mysmartlife.eu/mysmartlife/

Status Ongoing project

Start date 1 December 2016

End date 30 November 2021

The mySMARTLife project aims at the development of an Urban Transformation Strategy to support cities in the definition of transition models, as a suitable path to reach a high level of excellence in its development process, addressing the main city challenges and progress. IT aims at making the three Lighthouse Cities of Nantes, Hamburg and Helsinki, and the three Follower Cities Bydgoszcz, Rijeka and Palencia will learn from these experiences, more environmentally friendly by reducing the CO2 emissions of cities and increasing the use of renewable energy sources. Activities are focusing on "Inclusive Cities", offering a high quality of life to residents. "Smart People" are playing a vital role in their city's development. "Smart Economy" is an innovative and dynamic economic concept aiming at guaranteed employment and an adequate income, attracting talents and providing goods and services according to the actual requirements. The interventions planned and carried out in the three Lighthouse Cities also include innovative technological solutions in connection with refurbishments of buildings, usage of renewable energies, clean transport and supporting ICT solutions. An integrated planning process, where citizens are actively involved in the decision making, links the actions in different fields (e.g. mobility, sustainable energy, ICT). Following a structured city business

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model leads to an integrated urban transformation strategy, which can be easily transferred to other cities.

NALAB Urban Nature Labs

Grant agreement ID: 730052

https://unalab.eu/en

Status Ongoing project

Start date 1 June 2017

End date 31 May 2022

UNaLab will develop, via co-creation with stakeholders and implementation of 'living lab' demonstration areas, a robust evidence base and European framework of innovative, replicable, and locally-attuned nature-based solutions to enhance the climate and water resilience of cities. UNaLab focuses on urban ecological water management, accompanied with greening measures and innovative and inclusive urban design. The UNaLab partners aim to develop smarter, more inclusive, more resilient and more sustainable local societies through nature based innovation jointly created with and for stakeholders and citizens. UNaLab's 3 front runner cities: Tampere, Eindhoven and Genova, have a track record in smart and citizen driven solutions for sustainable development. They support 7 follower cities: Stavanger, Prague, Castellon, Cannes, Basaksehir, Hong Kong and Buenos Aires plus share experiences with observers as City of Guangzhou and the Brazilian network of Smart Cities. Therefore, UNaLab results will impact on different urban socio-economic realities, with diversity in size, challenges and climate conditions. In order to create an EU reference demonstration and go-to-market environment for NBS, UNaLab will use and further develop the ENoLL Urban Living Lab model, and the European Awareness Scenario Workshop method for the co-creation of solutions, and the roadmap approach, in this way achieving an innovative NBS toolbox. Roadmaps will be used in all 10 cities, but in particular serve the follower cities. VTT, with a track record in the field of urban sustainability and Smart Cities, leads UNaLab. The UNaLab consortium is comprised of 29 partners across 12 different European countries and three non-EU countries. The consortium is well-balanced, representing key stakeholders within the value chain of urban challenges and smart, sustainable cities (public bodies, research institutions, large industries, small and medium enterprises.

Ruggedised - Rotterdam, Umea and Glasgow: Generating Exemplar Districts in Sustainable Energy Deployment

Grant agreement ID: 731198

https://ruggedised.eu/home/

Status Ongoing project

Start date 1 November 2016

End date 31 October 2021

The RUGGEDISED project will create urban spaces powered by secure, affordable

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N°774477

and clean energy, smart electro-mobility, smart tools and services. The overall aims are:

1. Improving the quality of life of the citizens, by offering the citizens a clean, safe, attractive, inclusive and affordable living environment.

2. Reducing the environmental impacts of activities, by achieving a significant reduction of CO2 emissions, a major increase in the investment and usage of RES and an increase in the deployment of electric vehicles.

3. Creating a stimulating environment for sustainable economic development, by generating more sustainable jobs, stimulating community involvement in smart solutions and to boost start-up and existing companies to exploit the opportunities of the green digital economy and Internet of Things.

To achieve the aims, a key innovation challenge in all three lighthouse cities of RUGGEDISED is to arrange successful combinations of integrated smart solutions for energy and e-mobility (enabled by ICT platforms and open data protocols) and business models with the right incentives for stakeholders to invest and participate in a smart society. Specific challenges relevant for the lighthouse cities are:

- to manage peak load variation in thermal and electrical energy supply and demand;

- to develop appropriate cooperation structures and business models for exchange of energy;

- to develop Smart City (open) data platforms and energy management systems

RUGGEDISED has derived 10 specific objectives and planned 32 smart solutions to meet the challenges. The development of solutions in the lighthouse cities is not the primary goal of the project, but a necessary means to find the right incentives and to create validated business cases to enable large scale deployment and replication of solutions. Three follower cities Brno, Parma and Gdansk have selected 27 smart follower solutions to follow the lighthouse cities and to prepare for implementation in the future

REPLICATE

Grant agreement ID: 691735

https://replicate-project.eu/

Status Ongoing project

Start date 1 February 2016

End date 31 January 2021

The main objective of REPLICATE project is the development and validation in three lighthouse cities (San Sebastián - Spain, Florence – Italy and Bristol – UK) of a comprehensive and sustainable City Business Model to enhance the transition process to a smart city in the areas of the energy efficiency, sustainable mobility and ICT/Infrastructure. This will accelerate the deployment of innovative technologies, organizational and economic solutions to significantly increase resource and energy efficiency improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas. It aims to increase the quality of life for citizens across Europe by demonstrating the impact of innovative technologies used to co-create smart city services with citizens, and prove the optimal process for

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replicating successes within cities and across cities.

The Business Models that are being tested through large scale demonstrators at the three cities are approached with an integrated planning through a co-productive vision, involving citizens and cities' stakeholders, providing integrated viable solutions to existing challenges in urban areas and to procure sustainable services. Sustainability of the solutions is fostered in three areas: economic and environmental and finally, fostering transparency in the public management. In addition, the Model features the replicability of the solutions and their scale up in the entire city and in follower cities, particularly in three follower cities (Essen – Germany, Laussane - Switzerland and Nilüfer-Turkey) that are involved in the project and therefore, have access to know-how and results achieved on the project so they can apply the developed model. At the moment, there are 2 observer cities, Guanzhou (China) and Bogota (Colombia).

REMOURBAN - REgeneration MOdel for accelerating the smart URBAN transformation

Grant agreement ID: 646511

http://www.remourban.eu/

Status Closed project

Start date 1 January 2015

End date 30 June 2020

REMOURBAN aims at the development and validation in three lighthouse cities (Valladolid-Spain, Nottingham-UK and Tepebasi/Eskisehir-Turkey) of a sustainable urban regeneration model that leverages the convergence area of the energy, mobility and ICT sectors in order to accelerate the deployment of innovative technologies, organizational and economic solutions to significantly increase resource and energy efficiency, improve the sustainability of urban transport and drastically reduce greenhouse gas emissions in urban areas. The urban renovation strategy will be focused on the citizens, because they become the cornerstones to making a smart city a reality and will not only be the most affected by the improvements but also they will be the common factor of each of them.

ESPRESSO

Grant agreement ID: 691720

http://espresso.espresso-project.eu/

Start date 1 January 2016

End date 31 December 2017

systEmic Standardisation apPRoach to Empower Smart citieS and cOmmunities (ESPRESSO) focuses on the development of a conceptual Smart Cities Information Framework, which consists of a Smart City platform (the so-called Smart City enterprise application) and a number of data provision and processing services to integrate data, workflows, and processes in applications relevant for Smart Cities

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within a common framework. To build this framework, the project will identify relevant open standards, technologies, and information models that are currently in use or in development in the various sectors. It analyzes potential issues caused by gaps and overlaps across standards developed by the various standardization organizations and provides guidelines on how to effectively solve those issues. Particular emphasize will be put on common denominators in order to eventually allow for horizontal interoperability between the various sectors of a smart city. Though horizontal interoperability is out of scope for this project, emphasizing integration reference models as a key common denominator (e.g. in the form of multi-dimensional city models) already defines essential parts of the foundation for future levels of interoperability.

An Urban Platform, with a reference architecture and associated technical standards (over 400) have been identified (the project does not define new standards!). The reference architecture has already been picked up by DIN and used in actual project – it was made in close collaboration with the EIP SCC Urban Platforms, so it is supported by both the demand side (cities) and supply side (industry). ESPRESSO endorsed the Key Performance Indicators (KPI's) from the CITYKeys project, providing continuity in the research and application of KPI's. Long term strategic considerations for adopting standards in the various sectorial domains, taking into consideration technological trends and positioning future has been made available, including identification of economic and financial procurement models, market opening actions (start-up kits and deliverables). The ESPRESSO project has been active to pick up on speaking slots at Smart City events (including Smart City Expo in Barcelona) as well as actively organising our own webinars.

CPaaS.io - City Platform as a Service - Integrated and Open

Grant agreement ID: 723076

https://cpaas.bfh.ch/

Start date 1 July 2016

End date 31 December 2018

Data has been termed to be the „oil of the 21st century ". Data will also be what the smart city of the future runs on. To make this a reality, cities need a platform where data from a variety of sources – IoT and sensor data, open government data, social media, and other 3rd party data providers – can be processed, linked, and analysed in order to extract valuable information that in turn can also be provided as linked open data, and with which new types of services are created and provisioned. Both cities as well as private service providers can build novel applications and services on top of this platform; the platform thus becomes an economically valuable driver for Smart City Innovation.

The main goal of this project is to develop such a City Platform as a Service (CPaaS) that can be federated to support regional or even global applications, and that forms the basis for a smart city data infrastructure. Technical challenges that need to be addressed include data provenance, data quality, adaptive privacy levels, policies and adaptive processes for distributing and deploying processing intelligence to the cloud or to the edge. Other important aspects include data governance, data management and the empowerment of the citizen to control access and sharing of data about her using a MyData approach. In addition to the development of the platform, several use cases in the domains of event and transport management,

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water management, and health emergency services will be implemented and validated with cities in Europe and Japan. Blue prints – both from a technical as well as from a process perspective – for these domains that can easily be transferred and adapted from one region to another will be developed. This will for example allow transferring the learnings from the Asian Winter Games 2017 to the Tokyo Olympics 2020. And finally, the results from the project are used to develop standardisation proposals in the related areas to ensure impact beyond the project.
iKaaS - intelligent Knowledge-as-a-Service Platform Grant agreement ID: 643262 http://www.ikaas.com/ Start date 1 October 2014 End date 30 September 2017 iKaaS – (intelligent Knowledge-as-a-Service) Platform, developed an intelligent, privacy preserving and secure Smart City Platform based on a Big Data resource and an analytics engine built atop heterogeneous cloud platforms with data collected from a variety of sensors from Internet of Things (IoT) environments deployed as mobile terminals, smart devices, and smart homes. We envisage that these data and the analytics engine – a knowledge base – would be fundamental building blocks for cross-border business-to-government (B2G), business-to-business (B2B) and business-to-consumer (B2C) applications, such as lifestyle recommendation, future city planning, academic research and analysis, location-and behaviour-specific targeted services and so on. The platform features are demonstrated by means of Smart City applications promoting self-management of health and safety of citizens, as well as an information system improving data analysis for a smarter life in the city.

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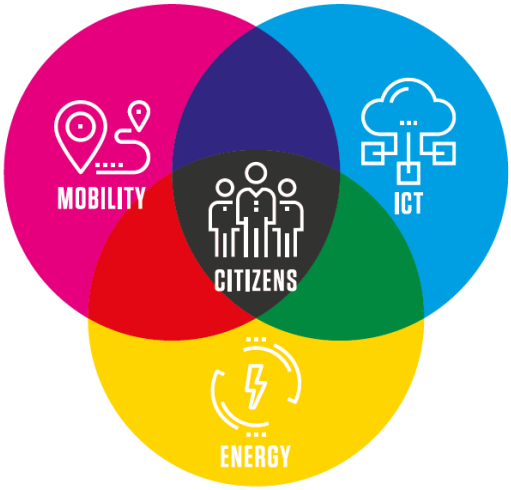
4 Integration strategies

The Integration strategies of Dresden Urban Platform according to the actions and interventions carried out are to be understood as an ongoing process A local ICT-Group with responsible participants of each partner action was set up to conduct the integration strategies on data, data collection and data procession through the Urban Platform.

In order to fulfil the integration of the several Dresden MAtchUP Actions and Interventions from the ICT perspective, the general description of the Integration strategies on Data collection, Data procession, and Data exchange is to be found in deliverable D3.24.



ENERGY

LESS ENERGY, MORE SOLUTIONS

MAtchUP aims to achieve high-performance districts through a series of interventions:

- improvements in buildings' energy efficiency,
- high integration of renewables in the energy supply,
- implementation of advanced energy management systems combined with innovative storage systems.

Moreover, an advanced management of the urban energy infrastructures will be set up, integrating innovative storage technologies to increase the global performance and RES contribution. Several innovative management systems will be deployed, from smart meters to overall recharging management solutions to reduce the grid impact.

MOBILITY

SMART SOLUTIONS, BETTER MOBILITY

New electromobility solutions, both for persons and goods, will be implemented in MAtchUP through new electric vehicles (EV) and charging infrastructures.

The most relevant actions that MAtchUP will implement in this area are:

- conventional vehicles replacement: more than 150 EV will be introduced,
- implementation of around 120 innovative charging infrastructures for e-vehicles and e-buses,
- improved logistic solutions, like last mile logistics based on e-Bikes, and
- multimodality strategies.

ICT

CONNECTED CITIES, LIVEABLE LIVES

MAtchUP will develop ICT solutions for improved planning management, control and maintenance of physical urban infrastructures and operational technologies in buildings, energy and transport, to enable better services for individuals and businesses.

An Open Specifications ICT concept will be established, defining a common approach in all functional requirements, software architecture and data structures to be designed and implemented.

Following this open specification concept, the current existing ICT models present in the cities will be improved with ICT solutions fully integrating at urban level to complement the demonstration.

CITIZENS

SMART CITIES, CITIZENS' CITIES

MAtchUP wants to redesign cities by complementing the technical solutions with a set of non-technical ones, such as specific social engagement activities, sustainable employment initiatives, staff exchange, city mentoring, and validation of innovative business models.

Different key actors – policy makers, universities, industry, investors and, most importantly, citizens – will join forces to develop smart models of innovation, inclusion and prosperity to restore cities' liveability.

MAtchUP aims to strengthen the city transformation strategies in a sustainable and inclusive manner, empowering citizens to participate in the planning process and integrating their voice in the replication and scale up plans.

Figure 4.1: Integration Strategy – Linking Energy, Mobility and Citizen Actions via and ICT Urban Platform Infrastructure

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In Dresden, it has been followed a more holistic view on the several actions and do think that adaptation and integration at the interfaces of the topic Mobility, Energy, and ICT are the most promising ones.

In order to carry out the MAtchUP project successfully, it was necessary to plan integration strategies of the current actions proposed, and describe this more detailed on how data will be gathered, transmitted and stored. Hence, this section describes data integration from the actions to be deployed in the Dresden city interventions. There are some social and non-technical actions aiming to foster citizen participation and engagement. The results from these actions regarding citizen involvement will be integrated in the urban platform, using the generated KPIs of these interventions.

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5 Open Data Adaptation

The commitment to open data for the city of Dresden was manifested on 3 September 2015, where the City Council commissioned the Lord Mayor with resolution A0076 / 15 to present an open data concept with the aim of making available open data from official procedures and data files of the city administration of Dresden online for free use. The concept was developed and decided on by the city council on 22nd May 2018. In order to promote administrative transparency and economy, datasets are being made available online ranging from education, culture, urban development and planning, environment to traffic and many more. Geo-data are provided in a reusable, vendor-independent format, which is suitable for automated processing. However, datasets are protected if they interfere with other laws or interests, e.g. privacy law. This means all data that are not protected as described before, will be accessible as open data. The further development of the Dresden Urban Platform will follow these guidelines for the future integration of the several Dresden MAtchUP Actions.

1. The state capital Dresden (LHD) introduces an Open Data portal. The data will be in a machine - readable, open and standardized format integrated in www.dresden.de made available.

2. The Open Data Portal starts with the datasets listed in Appendix 3 to the template and will be further developed with the involvement of external stakeholders.

3. The revenue loss expected from free provision of open data is suitably compensated.

Figure 5.1: City Council Decision on Open Data Concept

5.1 Open Data Specifications

Open data are data that “can be freely used, modified, and shared by anyone for any purpose”. Compared to proprietary frame-works, digital commons such as open data are characterized—from both a legal and a technical point of view—by lower restrictions applied to their circulation and reuse. This feature is supposed to ultimately foster collaboration, creativity and innovation [9].

Data generated within MAtchUP Actions integrated into the Urban Platform, and partially published on the Open Data Portal (see also D3.24). The data sets are accessible via CKAN (Comprehensive Knowledge Archive Network). In addition, a specific open data catalogue is compiled with those datasets generated during the project life time using the different data collection systems as sources. In order to ensure the interoperability of the implemented Open Data Portal with other existing Open Data catalogues and portals, it will also be included the necessary standard mechanisms (DCAT-AP) to enable the harvesting of datasets from external Open Data

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catalogues, as well as exporting Open Data sets to other external catalogues. The Open Data Portal is a strong tool for statistical analysis [https://opendata.dresden.de]. Since June 2019, the Metadata Catalogue provides a search function for exploring the 900+ urban data sets.

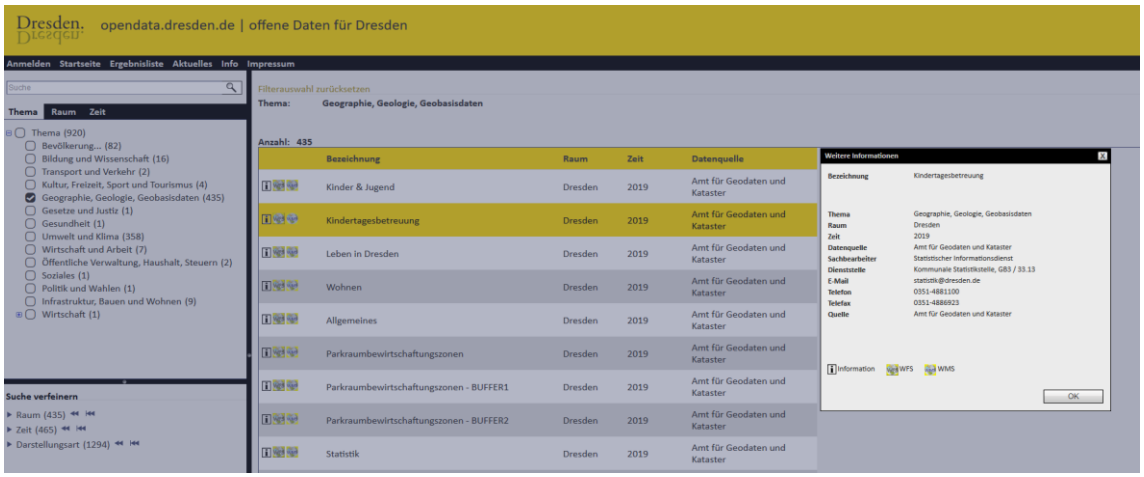

Figure 5.2: Open Data Concept – search function

5.2 Open Data Sources

Besides the already published data source within the Open Data Portal, the final decision about which data sets additionally may be published is still under negotiation. The Open Data Portal takes data from CARDO and KOMMIS_DD and data from DUVA. The data is provided in a machine-readable, open and standardized format. These formats include JSON, WMS, XML, CSV, TXT and in parts URL links to data provider. The database PostGreSQL (Open Source) has been widely used.

Details about chosen data formats:

Data format	Description
CSV	Comma separated values file is simply lines of data, with each data point separated from the next by a comma. CSV is perfect for tabular data and can be easily loaded into and saved from applications like Excel, making it accessible to users (https://www.europeandataportal.eu/elearning/en/module9/#/id/co-01)
JSON	JSON is a simple file format that is very easy for any programming language to read. Its simplicity means that it is generally easier for computers to process than others, such as XML. (http://opendatahandbook.org/guide/en/appendices/file-formats/)

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WFS	Web Feature Service offers direct fine-grained access to geographic information at the feature and feature property level. This International Standard specifies discovery operations, query operations, locking operations, transaction operations and operations to manage stored, parameterized query expressions. (https://www.opengeospatial.org/standards/wfs)
WMS	Web Map Service Interface Standard provides a simple HTTP interface for requesting geo-registered map images from one or more distributed geospatial databases. A WMS request defines the geographic layer(s) and area of interest to be processed. The response to the request is one or more geo-registered map images (returned as JPEG, PNG, etc) that can be displayed in a browser application. (https://www.opengeospatial.org/standards/wms)

5.3 Open Data Privacy and Security

According to the tasks of MAtchUP, data can be queried and explored in a uniform and interoperable way, which will be able to be replicated by other cities. The aim is to only publish non-sensible/no-private and anonymized data, taking into account privacy and security aspects and legal regulations

5.4 Open Data Operability

The data catalogue of MAtchUP project data with specifications, similar among all cities, will serve as the basis for the creation of a new catalogue of project data. For this, a template has been created jointly to define and fill in this catalogue. This is developed and applied for general data in Dresden and therefore encompasses not only open data. Currently, the template looks like this:

field	Description / Content
Name of the dataset	Concise name of the dataset (short but informative)
ID	Dataset identifier
Contact	Contact information for questions/remarks.
Description	Short description of scope/contents of the dataset. Also remarks (e.g. restrictions, data gaps).

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Category	Category from ISO19115 standard
	GEMET Key Words
Data source	Used sources to prepare/provide the dataset.
Date	Date of up-/download (e.g. 03/2019)
Access	Terms of data access/usage, e.g. • Confidential data for LHD-internal use only • Restricted access for user XY (e.g. research/ education) and non-commercial use only -> e.g. under CC-BY-NC 4.0 license) • Open access (e.g. under CC-BY 4.0 license)
Restrictions of use	E.g. not legal binding
Use of data and Purpose of creation	How the data can be used, reasons for development
Update frequency / granularity	Granularity (e.g. yearly / hourly / quarter-hourly data)
Timescale	Time period covered (e.g. 2010-2018)
Type of data acquisition	Batch/RT/no-RT
Formats	pdf, csv, geojson, kml, …
Vertical	ICT/Energy/Mobility/Social/Non-technical

Table 2. Dataset Template

Dataset Fields				
Name Field	**Description Field**	**Active/Static**	**Type Field**	**Units Field**

Table 3. Dataset Fields Template

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6 Open API Adaptation

Considering the aim of "openness", the current Urban Platform will need to be adapted and extended to provide open APIs for providing the capability of collecting, aggregating and analysing data, following the open data approaches. Hence, new Open APIs adapted to the city will be created and will also be offered to citizens.

6.1 Open APIs context

In the last few years, web API development has exploded, with over 2000 new APIs released on average each year. As the interfaces that enable applications to talk to each other over the internet, it's no surprise that more and more developers are creating and consuming APIs. With high growth comes the need for standardization to keep developing and moving quickly. The OpenAPI Specification provides that standardization with a structure and syntax for describing REST APIs that are both machine and human-readable. Adopting the OpenAPI Specification means creating a document that defines the specific REST API in OpenAPI's standard format. As an open source project that is language agnostic and vendor-neutral, which means it is widely adopted by the industry and is supported by a range of open source and proprietary tools.

OpenAPI was first launched in its initial guise as the Swagger Specification in 2011 and since then, it has been adopted by leading technology companies and start-ups. While many organizations use OpenAPI specifications for their private APIs, technology companies are also turning to the standard for their public web APIs, making it easier for developers to build apps that integrate with their platforms.

6.2 Benefits of Open API

There are benefits in several ways from Open APIs. An Open API is a useful tool for the developers community – it eases the co-creation of new services and functionalities of the developers among each other. Moreover, an Open API helps new developers to base on already existing codes to create more powerful applications. An Open API can improve existing services with less effort and time. Furthermore, most of the Open APIs are very well documented, with tutorials and examples of code of using the API, such as the Open APIs.

By Smart cities strategy Dresden will make more data available to citizens and third parties. As an easy access to public services and data of the city by means of Open APIs assure the benefit to various stakeholders, and a sustainable use and re-use of data. Hence, here tools to implement applications are identified but not broadly used among the several MAtchUP Actions. By using standardized and open API approaches, Smart cities Dresden offers opportunities to entrepreneurs for developing new businesses or services that improve the citizen life, governmental support and decision-making processes. Moreover, open APIs allows an automatically exchange of data and aggregated data between main pillars Energy and Mobility. Therefore, the

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benefits of each (individual) data set may be enhanced by its usage of different MAtchUP Partners during the project lifetime but later also by new parties to gain their own benefits or finding answers to their needs by using already monitored and captured data sets being made available via the Urban Platforms.

6.3 New City City APIs

Use cases, which involve time series data such as e-mobility charging station or the electricity consumption of public buildings, will rely on the SensorThings API specification that provides a generic model applicable to any type of measurement or observation.

The SensorThings API offers a JSON-based data model on either REST/HTTP or MQTT transport protocol. The sensors used in the project, e.g. for monitoring the parking spaces at the charging stations of the e-cars, only report changes (publish and subscribe via middleware). This capability already comes with the SensorThings AP. All other interfaces should follow this functionality. This will help in maintaining as few standards as possible and simplify the integration with the Urban Platform. (see also D3.24)

6.3.1 Existing APIs

6.3.1.1 Public buildings

For each building, the following time series are provided:

- Electricity consumption as consumption
- Drinking water meter reading
- Heat meter reading

API:	None, exchange via file transfer
Data format:	CSV
Available data points:	15 minutes
Available data points:	7 buildings
Notes:	Data files via exchange directory
Type of master data creation in SCDMS	Manual master data creation in SCDMS and automatic assignment to time series
Adding new data points	Automatically via file, assignment via metering code

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6.3.1.2 Charging stations

This service provides master data and status information for charging points in the city of Dresden.

API:	https://emobility-partner.de/services/secOchp13 / https://emobility-partner.de/services/ochp13
Data format:	JSON, XML
Period of data request:	5 minutes
Available data points:	402 charging connections and number of charging points
Notes:	The service provides available charging points with type & number of plugs. It gives information whether the plug is connected or not and whether there is current or not.
Type of master data creation in SCDMS	Automatically via the web service
Adding new data points	Adding new data points Only via the web service

6.3.1.3 Parking space availability

This service provides sensor data of parking spaces in parking lots. The status occupied/not occupied get delivered.

API:	https://api.parking-pilot.com
Data format:	JSON, XML
Period of data request:	5 minutes
Available data points:	147 sensors distributed over the Pirnaischer Platz parking lot and technology center
Notes:	Currently, 8 sensors are installed on the Pirnaischer Platz parking lot (4 public and 4 non-public) and 139 on the parking lot at the Technology Center (non-public)
Type of master data creation in SCDMS	Automatically via the web service
Adding new data points	Adding new data points Only via the web service

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6.3.1.4 Smart Rain Data Points

The service provides weather data based on an open API. The SmartRain data points are provided by the company PIKOBYTES GmbH from Dresden.

API:	https://opensensorweb.de
Data format:	CSV
Period of data request:	5 minutes
Available data points:	See https://opensensorweb.de
Notes:	None.
Type of master data creation in SCDMS	Manual master data creation in SCDMS and manual assignment to data points
Adding new data points	Manuell im SCDMS

6.3.1.5 Temperature

API	api.openweathermap.org/data/2.5/weather?q={city name}&appid={your api key}
Data format:	Number
Period of data request:	15 minutes
Data source	OpenWeatherMap.org

6.3.1.6 Planned APIs

There are APIs which may be developed in the future to send data from car loggers to the Urban Data Platform. It is also planned to create lighting sensors to establish Smart Lighting around the city of Dresden. However, at this point in time no specifications on structure or accessibility can be made.

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7 Big Data Functionalities and Adaptation

Big data is a massive volume of both structured and unstructured data that is so large that it is difficult to process using traditional database and software techniques. Big data technologies have great impacts on scientific discoveries and value creation [10]. Nowadays, large data volumes are daily generated at unprecedented rate from heterogeneous sources (e.g., health, government, social networks, marketing, financial). This is due to many technological trends, including the Internet of Things, the proliferation of the Cloud Computing [11] as well as the spread of smart devices. Besides general cloud infrastructure services, technologies such as Hadoop, Databases/Servers SQL, NoSQL, and MPP databases, etc. are also used to support Big Data [12].

To extract knowledge from Big Data, various models, programs, soft-, hardware and technologies have been designed and proposed. They try to ensure more accurate and reliable results for Big Data applications. However, in such environment, it may be time consuming and challenging to choose among numerous technologies. In fact, many parameters should be considered: technological compatibility, deployment complexity, cost, efficiency, performance, reliability, support and security risks. Most data scientists and experts define Big Data by the following three main characteristics [13]:

- Volume: Large volumes of digital data are generated continuously from millions of devices and applications (ICTs, smartphones, products' codes, social networks, sensors, logs, etc.). In 2013, the total digital data created, replicated, and consumed was estimated by the International Data Corporation (a company which publishes research reports) as 4.4 Zettabytes (ZB). It is doubling every 2 years. [14]

- Velocity: Data are generated in a fast way and should be processed rapidly to extract useful information and relevant insights. For instance, Walmart (an international discount retail chain) generates more than 2.5 PB of data every hour from its customer transactions. YouTube is another good example that illustrates the fast speed of Big Data.

- Variety: Big Data are generated from distributed various sources and in multiple formats (e.g., videos, documents, comments, logs). Large data sets consist of structured and unstructured data, public or private, local or distant, shared or confidential, complete or incomplete, etc.

Some actors to better define Big Data: Vision (a purpose), Verification (processed data conform to some specifications), Validation (the purpose is fulfilled), Value (pertinent information can be extracted for many sectors), Complexity (it is difficult to organize and analyse Big data because of evolving data relationships) and Immutability (collected and stored Big data can be permanent if well managed).

Big Data challenges The mining of Big Data offers many attractive opportunities. However, researchers and professionals are facing several challenges when exploring Big Data sets and when extracting value and knowledge from such mines of information. The difficulties lye at different levels including: data capture, storage,

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searching, sharing, analysis, management and visualization. Furthermore, there are security and privacy issues especially in distributed data driven applications. Often, the deluge of information and distributed streams surpass our capability to harness. In fact, while the size of Big Data keeps increasing exponentially, the current technological capacity to handle and explore Big Data sets, is only in the relatively lower levels of petabytes, exabytes and zettabytes of data.

Big Data management Data scientists are facing many challenges when dealing with Big Data. One challenge is how to collect, integrate and store, with less hardware and software requirements, tremendous data sets generated from distributed sources. Another challenge is Big Data management. It is crucial to efficiently manage Big Data in order to facilitate the extraction of reliable insight and to optimize expenses. Indeed, a good data management is the foundation for Big Data analytics. Big Data management means to clean data for reliability, to aggregate data coming from different sources and to encode data for security and privacy. It means also to ensure efficient Big Data storage and a role-based access to multiple distributed end-points.

Big Data cleaning The five steps (Cleaning, Aggregation, Encoding, Storage and Access) are not new and are known in the case of traditional data management. The challenge in Big Data is how to manage the complexity of Big Data nature (velocity, volume and variety) and process it in a distributed environment with a mix of applications. In fact, for reliable analysis results, it is essential to verify the reliability of sources and data quality before engaging resources. However, data sources may contain noises, errors or incomplete data. The challenge is how to clean such huge data sets and how to decide about which data is reliable, which data is useful.

Big Data aggregation Another challenge is to synchronize outside data sources and distributed Big Data platforms (including applications, repositories, sensors, networks, etc.) with the internal infrastructures of an organization. Most of the time, it is not sufficient to analyze the data generated inside organizations. In order to extract valuable insight and knowledge, it is important to go a step further and to aggregate internal data with external data sources. External data could include third-party sources, information about market fluctuation, weather forecasting and traffic conditions, data from social networks, customers comments and citizen feedbacks. This can help, for instance, to maximize the strength of predictive models used for analytics.

Imbalanced systems capacities An important issue is related to the computer architecture and capacity. Indeed, it is known that the CPU performance is doubling each 18 months following the Moore's Law, and the performance of disk drives is also doubling at the same rate. However, the I/O operations do not follow the same performance pattern. (e.i, random I/O speeds have improved moderately while sequential I/O speeds increase with density slowly). Consequently, this imbalanced system capacity may slow accessing data and affects the performance and the scalability of Big Data applications. From another angle, we can notice the various devices capacities over a network (e.i, sensors, disks, memories). This may slow down system performance.

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7.1 Big Data Analysis Platforms

Big Data analytics Big data brings big opportunities and transformative potential for various sectors; on the other hand, it also presents unprecedented challenges to harnessing such large increasing volumes of data. Advanced data analysis is required to understand the relationships among features and explore data. For instance, data analysis enables an organization to extract valuable insight and monitor the patterns that may affect positively or negatively the business. Other data driven applications need also real-time analysis, like navigation, social networks, Finance, biomedicine, astronomy, intelligent transport systems. Thus, advanced algorithms and efficient methods of data mining are needed to get accurate results, to monitor the changes in various fields and to predict future observations. However, big data analysis is still challenging for many reasons: the complex nature of Big Data including the 5Vs, the need for scalability and performance to analyse such tremendous heterogeneous data sets with real-time responsiveness.

Nowadays, there are various analytical techniques including data mining, visualization, statistical analysis, and machine learning. Many studies tackle this area by either enhancing the used techniques, proposing new ones or testing the combination of various algorithms and technologies. Thus, Big Data pushed the development of systems architectures, the hardware as well as software. However, we still need analytical advancement to face Big Data challenges and stream processing. One of the issues is how to guarantee the timeliness of response when the volume of data is very large? In the following sub-sections, we explore examples of the difficulties encountered when applying current analytical solutions: Machine learning, deep learning, incremental approaches, granular computing.

7.2 Big Data Collection and Analysis

In order to prepare, develop and implement the necessary big data IT infrastructure the following items need to be considered: allocated large amounts of redundant disk space in data centres, virtual machines, server-side processes and databased to receive data, specified data schemes and database setups, specified long-term data storage and short-term storage of aggregated and pre-processed. Taking into account stakeholder workshops, user needs, scenarios, use cases and requirements, the following big data processes are identified and specified:

- ✔ data acquisition processes
- ✔ data integration
- ✔ data analysis
- ✔ data provision
- ✔ information visualization
- ✔ information exploring

So far, first investigations and a brief comparison on exciting and to be further developed software components were carried out.

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7.3 Big Data Visualization and Dashboards

Within MAtchUP, **Big Data** is defined as very large sets of data that are produced by people using the internet, and that can only be stored, understood, and used with the help of special tools and methods.

7.3.1 Big Data Functionalities – A62

So far, here mainly Action 62 is being involved. The functionalities aim to cover the data analysis activities for the calculation of new insights associated to the planned interventions in Dresden. The exploitation of available historic and real time data, will create new insights on the energy optimization, sustainable mobility, high performance buildings and environment.

A set of common data analytic functionalities prepared for reuse will be created to enable the design of more complex big data analysis required. Within Action 62, a big data cluster gathers all raw continuous data coming from vehicles via on-board-units.

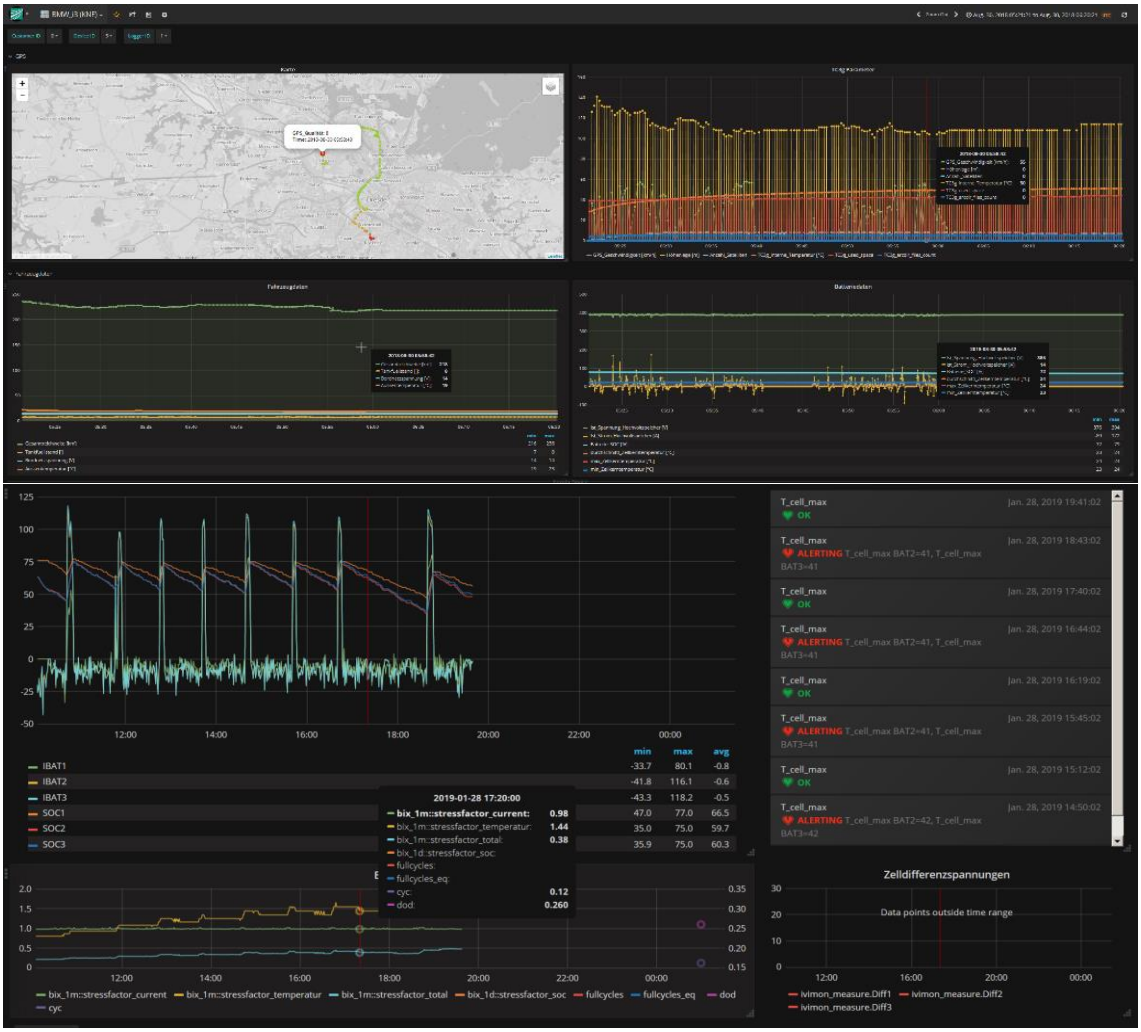

Figure 7.1: Big Data User Interface (by FhG)

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The data is stored and provided to certain analytics modules, executed in the big data cluster, in order to calculate specific KPI (such as the load predictor algorithm). The calculated data is provided to further use by other actions. For Instance: the load prediction model from A23 is going to be implemented as big data module, refinement of big data analytics user interface (see Figure 7.1) or the evaluated performance of charging load (reference to A23) as a prediction module for being used in Big data analytics and adaptations. This is still an ongoing operation and needs also further developments. E.g. regarding the integration of further vehicle data (Action 19) into this analytics

Moreover, Dresden will develop an open data gateway, mobility services including balance the grid load with storage and charging stations and decision making systems based on big data together with citizens' engagement services in the urban platform.

The vehicles acquired by the partners will be equipped with a monitoring and telematics platform developed by FHG; besides commercially available telematics devices, which will be programmed by FHG to transmit locally acquired data incl. position data to a Cloud-Service. The latter will also be developed by FHG. Care will be taken to take existing data privacy considerations into account.

The next image depicts a work flow from the source to the final web platform. The platform will be able to accept data from a multitude of up to 100 vehicles at a time, and to display the information in an adaptable and customizable form in a web interface. Basic analysis and KPI generation will be easily implementable.

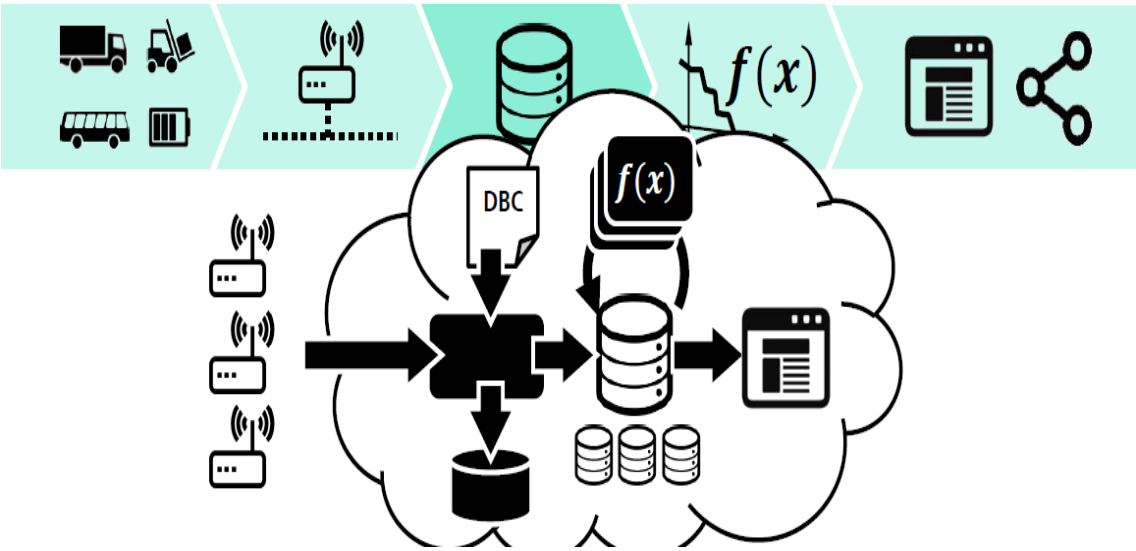

Figure 7.2: Big Data Schematics of the telematics activity: how raw data is transmitted

Availability of database for CAN-bus logging and data protection:

- ➔ explanations to the municipality and contracts for data handling
- ➔ Contact to car manufactures and additional sources of information

- ●.1 Number of vehicles monitored
- ●.2 Average energy consumption of the e-vehicles

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- ●.3 Total number of users
- ●.4 Reduction in energy consumption per passenger
- ●.5 Annual CO2 emissions saved
- ●.6 Decreased emissions of Nitrogen Dioxides
- ●.7 Decreased emissions of Particulate Matter
- ●.8 Ratio of electrically driven km/ all km
- ●.9 Trip distance

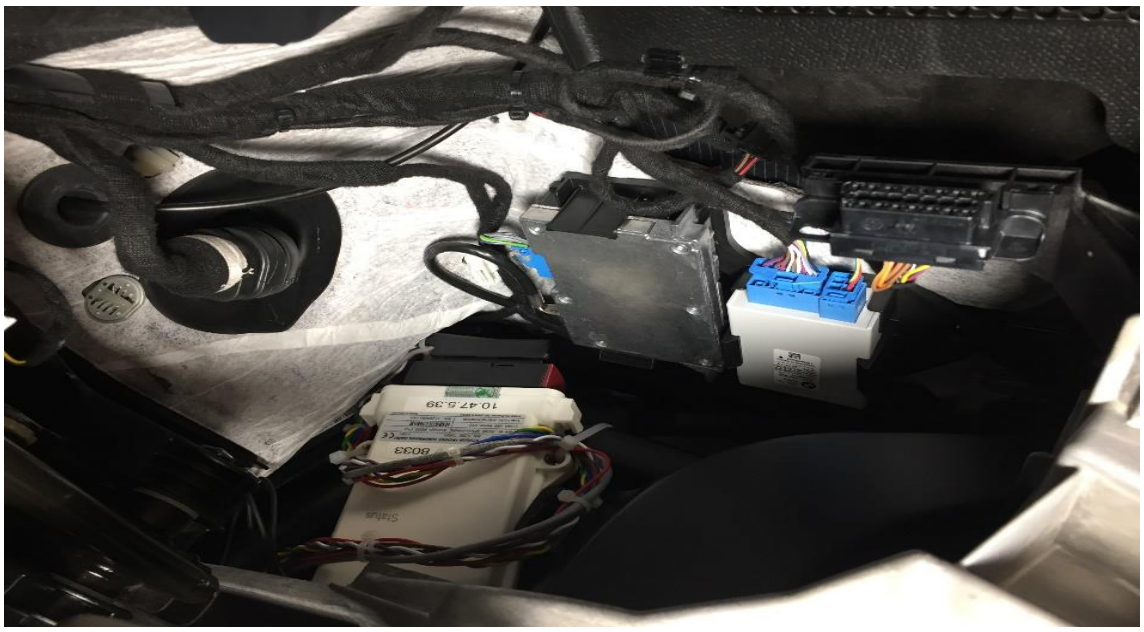

Figure 7.3: Big Data Schematics of the telematics activity: raw data is transmitted

Rollout to additional electrical vehicle (particularly eGolf or BMW i3) and investigations on database of VW ID.3, if municipality includes this vehicle type to the fleet, are the next steps.

7.3.2 Optimal use of charging infrastructure – A23

Charging fleets of electric vehicles may result in load peaks during evening main charging time. If the actual energy consumption (in terms of Stat of Charge) does not correspond to the original planned driving requirement (in the sense of positive or negative deviation), there might by unwanted effects for energy resource allocation. An innovative prediction system based on telemetry will provide a much more accurate load forecast for the expected electric load and is inherent part of the input-output energy broker of the district storage system (Action 18). High invest barrier will be lowered by more exact demand forecasts and a more precise charge requests will play a crucial role for an economic operation of a district storage system. The technical installation of the predictive charge request system will be based in telemetry units installed in the monitored EVs, data receiver, raw data management and load predictor algorithm that will be connected to the district storage system.

The battery data from EVs, collected within A19, is used in this action in order to predict charging demand forecasts based on the current state of charge. This demand forecast is provided to other MAtchUP actions, such as A24. The calculation of the

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demand forecast makes us of the big data functionalities from A62. Because the outcome of this action is an algorithm and data model, direct indicators specific for this action are not measurable.

However, in conjunction with Action 54, the Energy Indicator "E5) Peak Load Reduction" mentioned in Deliverable D5.1 will be measured as part of Action 54 "Reducing the impact of charging stations on the grid":

- Number/percentage of charging processes in accordance with the system's proposed charging time slots
- Impact of charging processes on the power network
- Amount of users for booking system

Different approaches were investigated to develop a software module, which is able to predict the charging demand of a vehicle till it reaches the charging station. The following picture shows the principal opportunities.

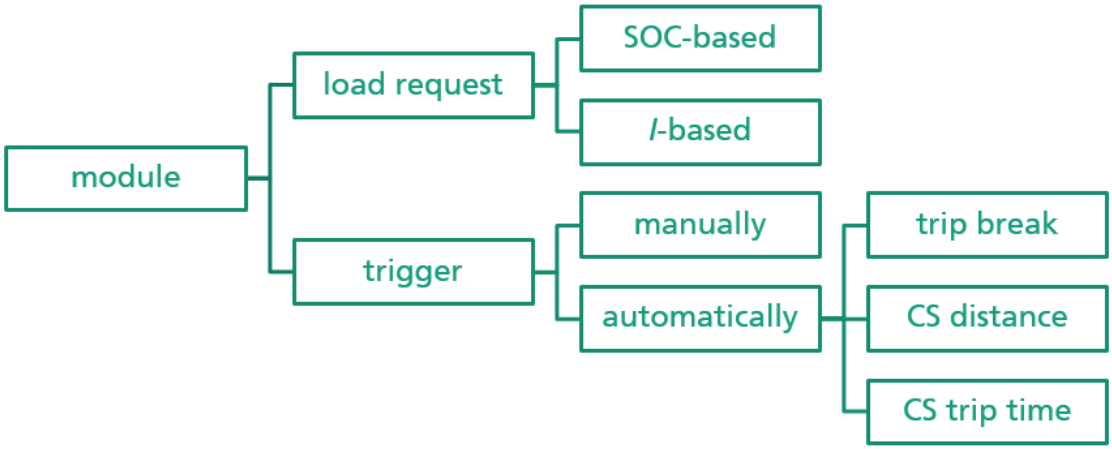

Figure 7.4: Big Data Schematics predict the charging demand.

Based on that ,some test implementations were carried out to compare the different approaches more in detail. The following picture shows the comparison results:

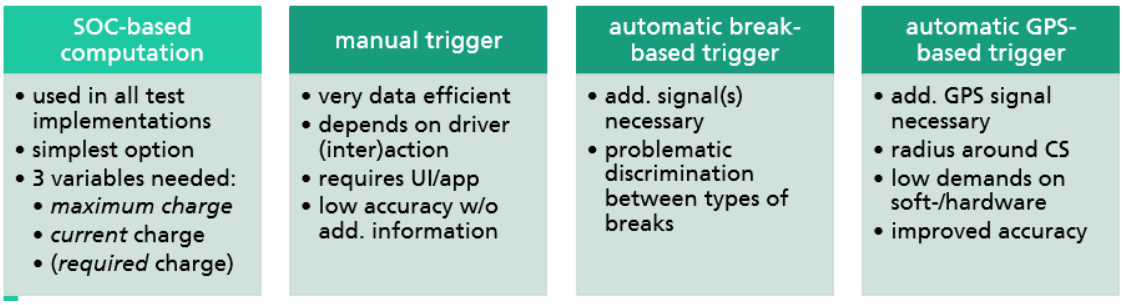

Figure 7.5: comparison of different approaches

Compared to the boundary conditions of the project, where no driver interaction with any system linked to the charging prediction is possible and the vehicles monitored are fleet vehicles of the municipality, the most suitable solution is an automatic GPS-based trigger. This solution calculates the energy demand depending on its distance to the next charging stations. If it comes close enough, a trigger is activated and calculation of energy demand is calculated including an estimation for energy demand for driving to the charging station in the home base. This approach was implemented and tested in details. The estimated results were compared to the really charged energy and an error

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below 1,2 % is very good enough for the relevant use cases. Finally, the calculation was implemented to the Big-Data infrastructure to automatically calculate the charging demand based on the GPS-Trigger.

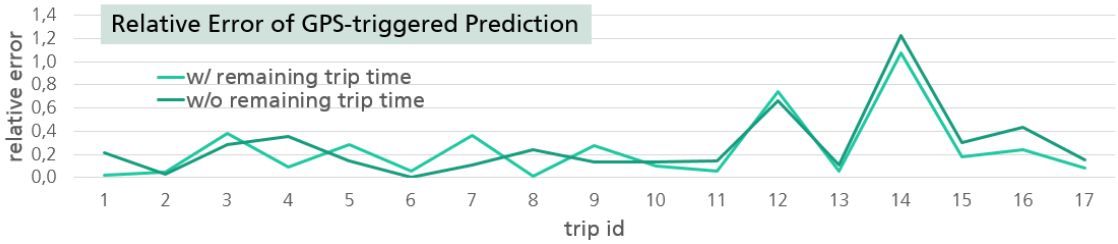

Figure 7.6: Big Data - relative error of GPS-triggered prediction

7.3.3 Open Data Portal – KPI Visualization

Mainly within the development of the Open Data Portal Big data visualization is already established and being used. To transfer the existing Knowledge to other Actions and application the next period is going to be used. Software implementation of the following processes into the user application:

- ✔ information visualization
- ✔ information exploring

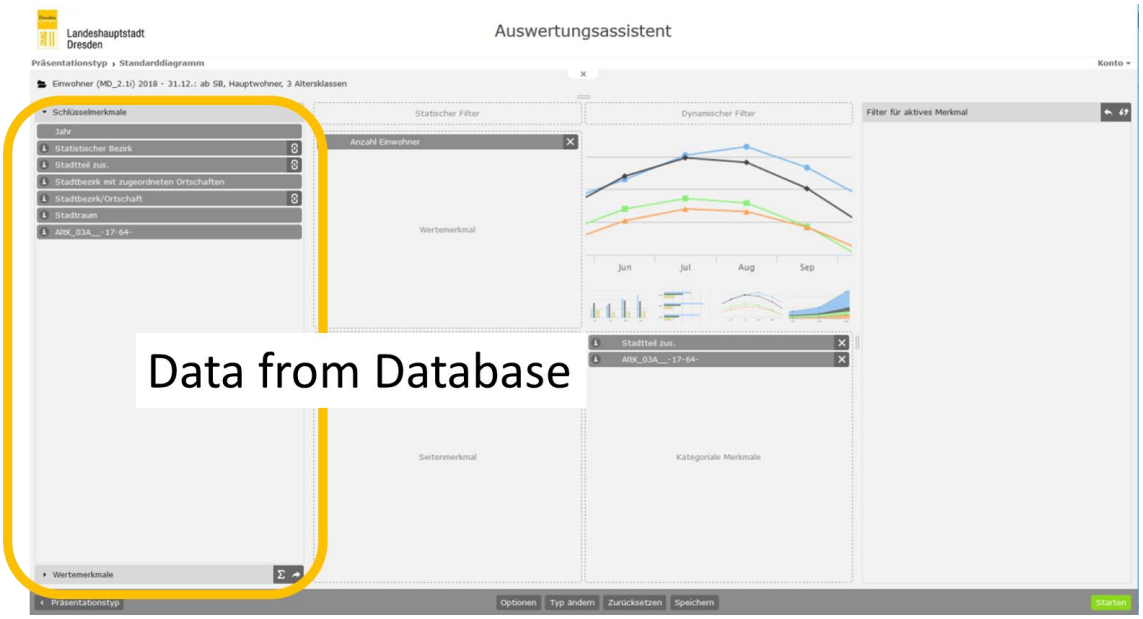

Figure 7.7: Open Data Portal – KPI Visualization – Data selection

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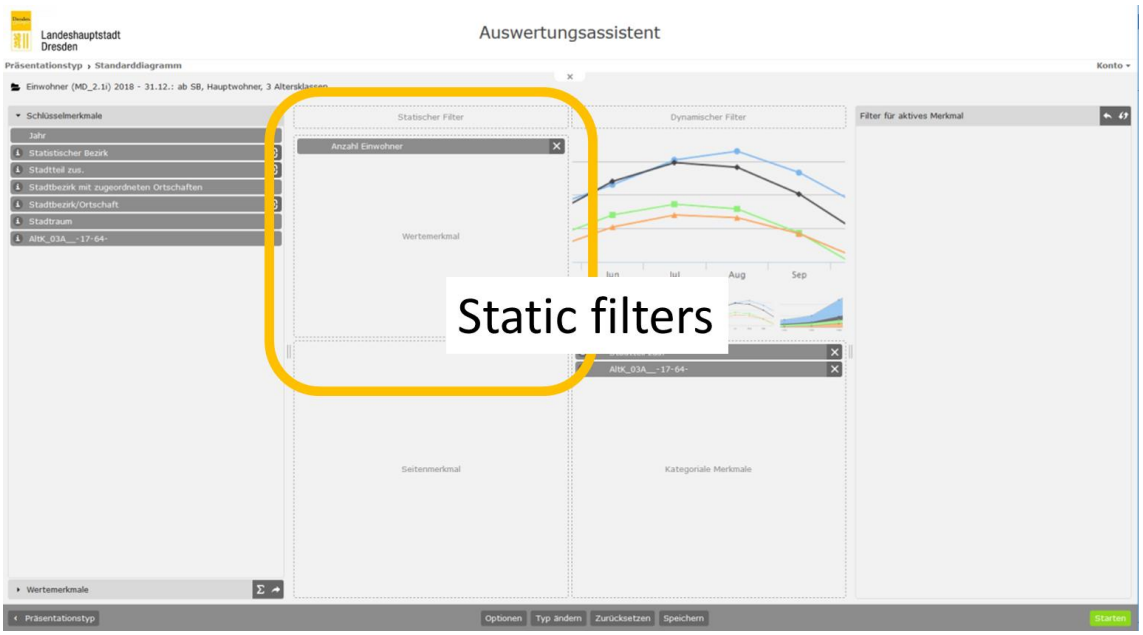

Figure 7.8: Open Data Portal – KPI Visualization – static filtering

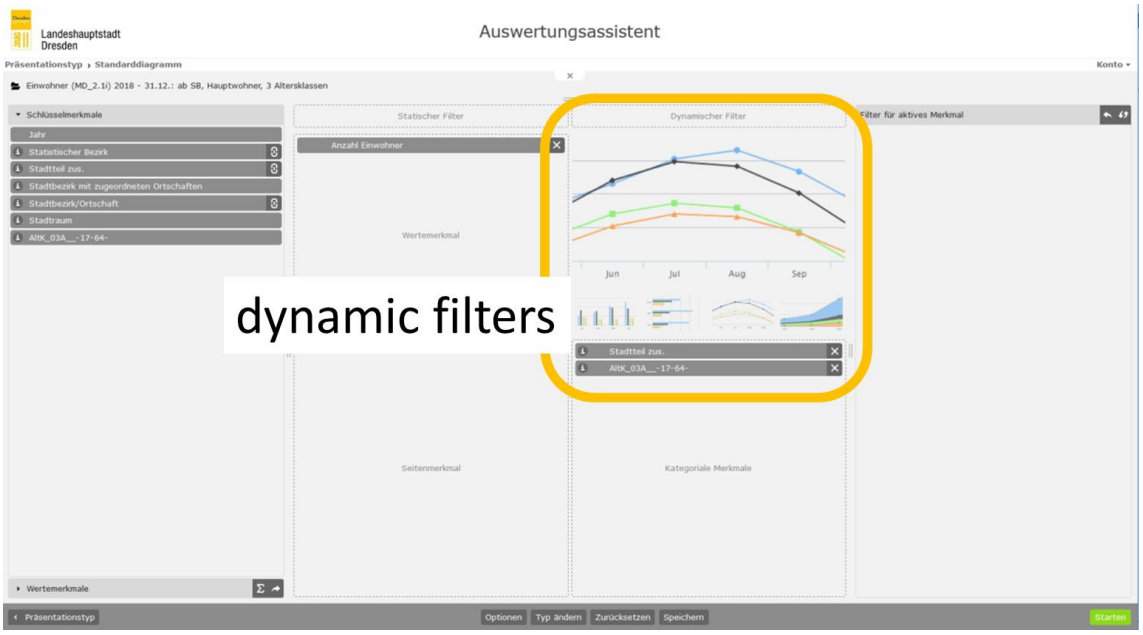

Figure 7.9: Open Data Portal – KPI Visualization – dynamic filtering

7.4 Application of Machine Learning Methods to Big Data

In Dresden case, it is necessary to figure out on existing (scientific and technological) approaches on how information may be better explored by use of machine learning approaches and if this can be implemented to the Urban Platform. The evaluation process (ROC curves, etc.) of the machine learning may be resulting as an interoperability assurance among different MAtchUP data sources.

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7.4.1 Building control center – KPI Visualization (DREWAG)

Main goal of Action A2 is to improve the energy efficiency of public buildings. Therefore, EASD models one representative school building in the district using the A1 modeling approaches. Besides building performance analyzes and optimization, the models are used to implement and test predictive heat control algorithms, mainly regarding a permanent adaptation of heating depending on outdoor and indoor conditions. Dresden wants to add the public buildings to its Central Building Control Center (CBCC), a platform for data monitoring and evaluation and building energy management. To support a permanent high energetic standard of the connected buildings, EASD exemplary shows efficient measures of data evaluation and system optimization including models and monitoring data for the selected representative school building.

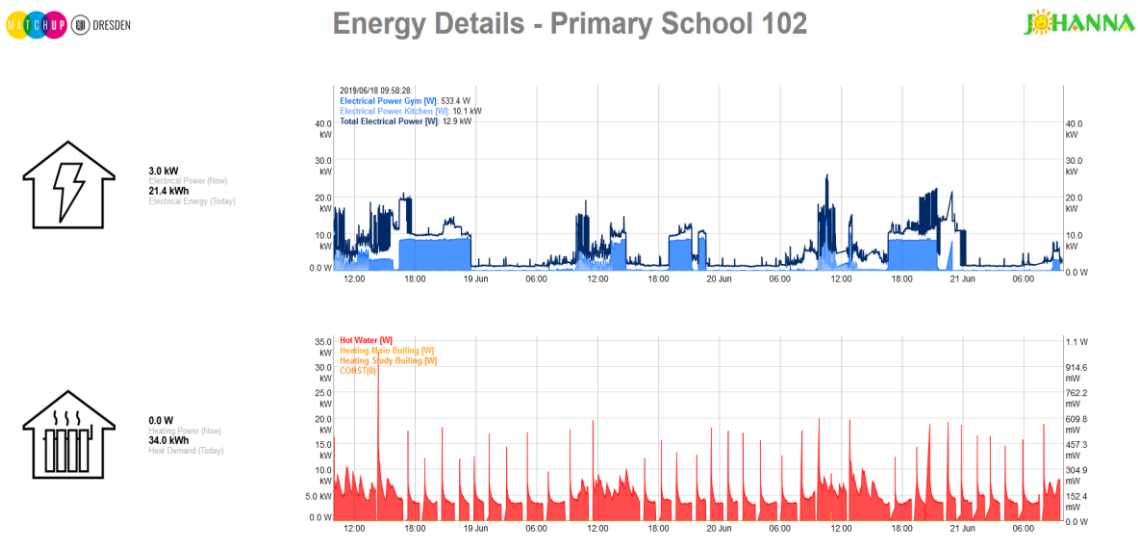

Figure 7.10: Building Control Centre – KPI Visualization

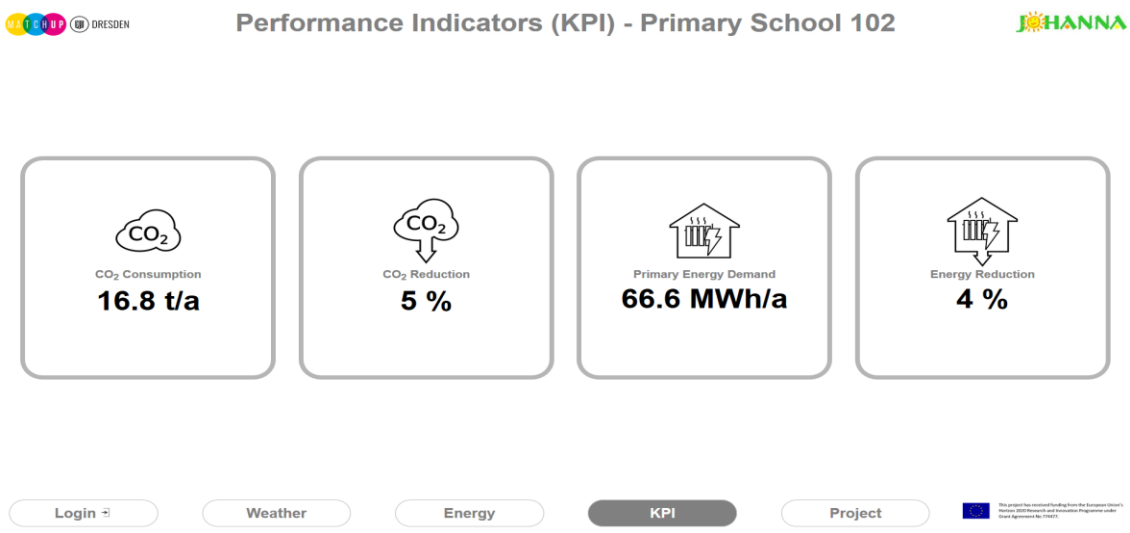

Figure 7.11: Building Control Centre – interactive live update

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To evaluate specific use-cases of a central building control center for public buildings, the collection of relevant data as well as different strategies of data application as well as suitable system interventions of this new superordinate control entity need to be tested in advance on a specific example building. This pilot building in MAtchUP is the 102nd elementary school (i.e. Pfotenhauer Str. 40 in the smart city district Johannstadt). This school building is a standardized building type. Thus, results can be transferred to many other buildings in the city and beyond.

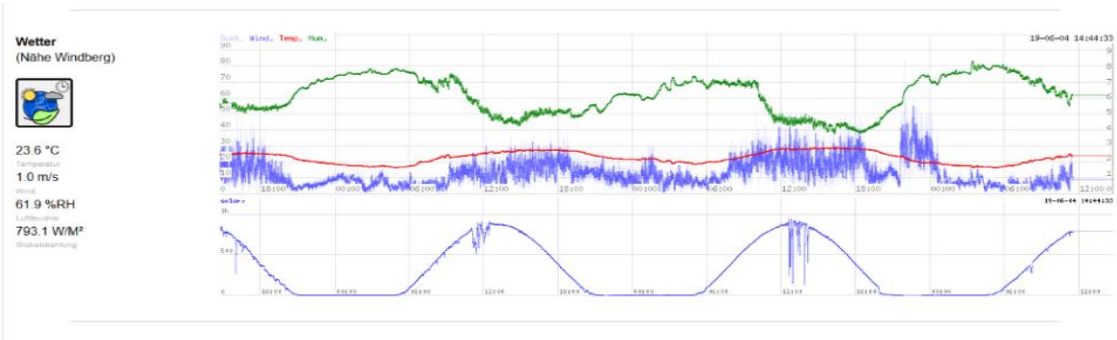

Figure 7.12: Data visualization by the monitoring platform

The implemented metering infrastructure allows to directly transfer measurement data of heating and power supply system as well as local weather data to the Building Control Center. Permanently installed room temperature measurement will be added in the next months to replace temporal mobile measurement devices. There, the data is used for different use cases, e.g. engineering-based data evaluation and system optimization, model calibration, test of advanced control algorithms incl. forecast or at least public services. The implemented platform allows to visualize, export or convert the collected data for any relevant purposes which might occur in public use cases (Figure 7.12). It is thus an ideal platform to test new methods of data handling in the field of public buildings for the whole city.

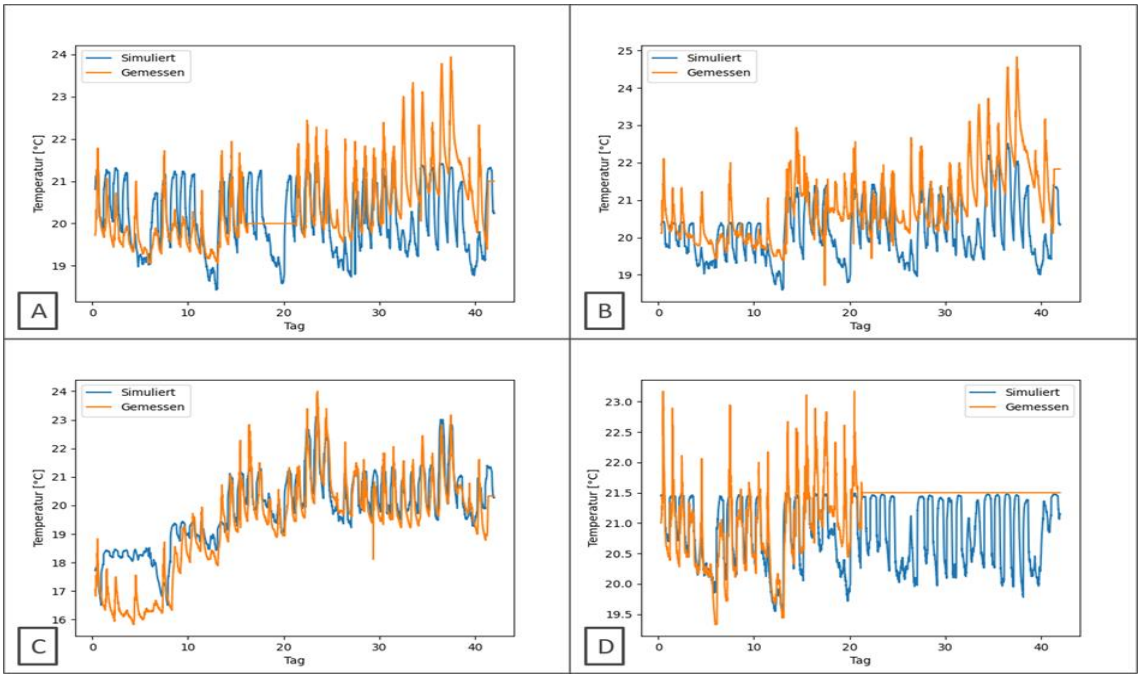

Figure 7.13: Exemplary calibration results

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In this energy-related action, simulation models are necessary to evaluate different measures of system optimization regarding both energy system configuration (e.g. hot water supply of the school building) and system control (e.g. flow temperature control of the heating system). The implemented simulation models represent the thermal behavior, power consumption and occupancy of different relevant rooms with high accuracy. To increase this accuracy, they have been calibrated with the collected measurement data from the first year of measurements, i.e. a hybrid digital twin model has been built. With the help of the implemented and calibrated models, the energetic behavior of the building including occupancy has been digitally replicated.

System optimization based on engineering analyzes is one of the major use cases of the Building Control Center. This use case has been conducted with both developed platforms and toolsets, the monitoring infrastructure and the digital twin model. As an example of the results, Figure 7.14 show an evaluation of the heat vs. power consumption curve of different system variants which have been evaluated with the measurement data (i.e. blue curve representing current status) and the model (i.e. red curve, representing alternative solution).

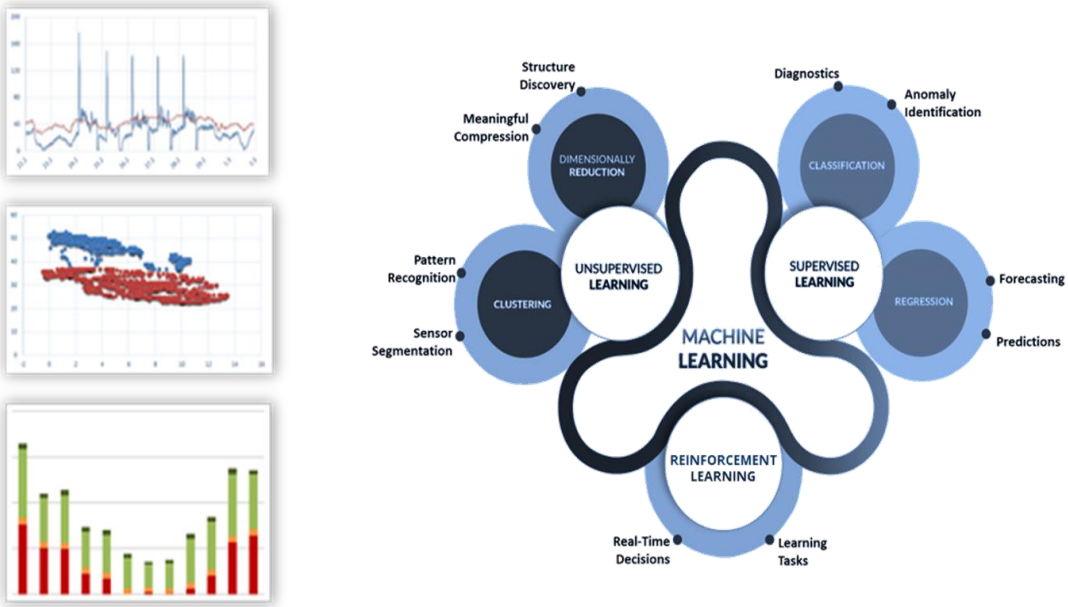

Figure 7.14: Test and implementation of Machine Learning algorithms based on available data

Smart interactive control algorithms: they mainly consist of mono-valent heat and power supply systems (i.e. heating via district heating grid and power supply via public power grid) and thus the degree of freedom is low. However, the heating system, as the main energy consumer in the 102nd elementary school, provides one relevant access for superordinate controllers, the flow temperature. It is currently controlled depending on the outdoor temperature as well as the building occupancy. Extensive investigations showed based on available data and simulation results that an optimized flow temperature control can provide additional energy savings.

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7.5 Benefits of Big Data Analysis

Machine learning is an important area of artificial intelligence. The objective of machine learning is to discover knowledge and make intelligent decisions. Machine learning algorithms can be categorized into supervised, unsupervised, and semi-supervised. When big data is concerned, it is necessary to scale up machine learning algorithms). Another categorization of machine learning according to the output of a machine learning system includes classification, regression, clustering, and density estimation, etc. Machine learning approaches include decision tree learning, association rule learning, artificial neural networks, support vector machines (SVM), clustering, Bayesian networks, and genetic algorithms, etc. Machine learning has been used in big data. Massive parallel-processing (MPP), distributed file systems, and cloud computing, etc. support Big Data [15].

Most advances for scalable machine learning (e.g. Madlib, Apache Mahout, etc.) happen in the massively parallel database processing community. Better work can be done in the Big Data era by designing and implementing ML algorithms with scale-friendly predictive functions. The following methods have been exploring and evaluating [16]

- (i) deep learning algorithms that automate the feature engineering process by learning to create and sift through data-driven features,
- (ii) incremental learning algorithms in associative memory architectures that can seamlessly adapt to future datasets and sources,
- (iii) faceted learning that can learn hierarchical structure in the data, and
- (iv) multi-task learning that can learn a number of predictive functions in parallel.

The estimated benefits of Big Data analysis need still to be adapted to Dresden context. But generally speaking the main benefit is given by the use big data analytics for exploring and exploiting various data collected from different sources, containing various types and data format, mixing structured, semi-structured and unstructured data in a large scale in order to assist and support decision-making processes.

Advanced analysis may include predictive models and pattern analysis, to obtain an aggregated worth over data. Hence, the speed of carrying out the analysis is another benefit regarding a short term, quickly performance in order to have results immediately available.

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8 Urban Platform outlook

Future work in the context of Dresden´s Urban Platform and MAtchUP will specifically target the better linkage and integration of data, as well as the capacity for analysing quickly growing amounts of data. The local ICT group is set up to implement the strategies on data, data collection and data processing through the UP of Dresden. Following issues will be addressed next.

8.1 Open Data, open APIs and Real-Time

To promote administrative transparency and boost local economy, additional datasets form education, culture, urban development, environment, traffic and others will be made available online. Geo-data will be provided in a reusable, vendor-independent format suitable for automated processing.

8.2 Big Data collection, analysis and visualization on the UP

A user interface application is under development, while software criteria are being defined in regards to information visualization and exploration that can ease the usability for different users. A Big Data strategy will be established and key benefits explored that can be derived from analytics of big (urban) data, collected from various sources, containing various types and data formats (non-standardized, semi-structured, unstructured). The further development work will comply with following processes: data acquisition - data integration - data analysis - data provision - information visualization.

8.3 Monitoring and ICT-Indicators

The next milestone in the MAtchUP project is the monitoring process of the UP. For this six ICT indicators were identified:

1) Improved interoperability, 2) Accessibility of open data, 3) Increase in online government services, 4) New open data sets by type of services, 5) Quality of services through open APIs provided, and 6) Number of users of the service (see follow Figure).

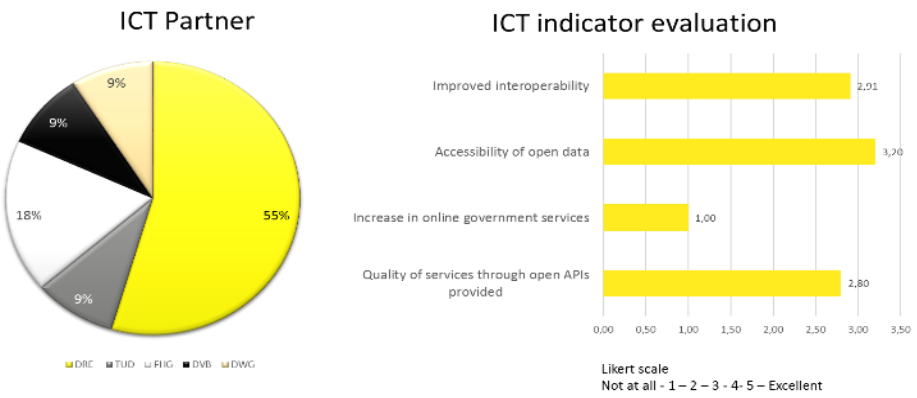

Figure 8.1: Urban Platform – ICT Indicator Evaluation

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These computable indicators allow a precise monitoring of the UP´s development over next two years. The calculations follow a standardized quantitative method combined with qualitative measures. The MAtchUP actions have already improved Dresden's e-government services and will further support the development and provision of new offers. However, more datasets need to be exploited in order to fulfil the Open Data Commitment mandated by the city council on 22nd May 2018. Interoperability at API level is necessary to enable third parties develop new services on a high-level, adapt their software assets to the UP, and gain larger visibility and outreach. The creation of API that allow data exchange and interoperability between the solutions of the MAtchUP partners is the next immediate development goal.

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9 Conclusion

In D3.22, it is reflected the work done in regards conceptual approach, development and further outlines of the Urban Platform adaptation specifications in the city of Dresden. There is a brief description of the main objectives and outcomes mainly by explaining the systems and applications in use and further development during the first 38 months of the MAtchUP projects. The requirements and specifications were described according to the identified need of components for enhancing the city services according to the MAtchUP interventions.

The overall concept as well as the IT architecture of the Dresden Urban Platform has been detailed, linked to some reference European projects dealing with Data Platforms and related European urban projects. The ongoing integration strategies were reflected in order to the MAtchUP intervention in the pillars of mobility, energy and ICT actions together with the non-technical interventions. The current state of work according to Open Data and open API Adaptations was summarized and Big Data approaches been analysed.

In summary, by extending and adapting Dresden Urban Platform, the city will be able to provide new services to citizens, improving the quality of life and well-being, while increasing transparency and business opportunities for entrepreneurs.

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