D1.6 – Legal Aspects

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Abstract

A Digital Twin is built up from all available data sources, predictions, and expected results, which are available in the given construction site. Major part of the data is coming from sources, which may be regulated due to legislation and/or personal data protection. This deliverable discusses the possibilities and limitations of use of such sources. Analysis is carried out on the industrial pilot use-cases in the project.

Keywords

Legislation, GDPR, FAIR, Anonymization, Personal Data, Analysis, Construction Site

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Acronyms and definitions

Acronym	Meaning
AECO	Architecture, Engineering, Construction & Operations
BIM	Building Information Modelling
IFC	Industry Foundation Class
BLE	Bluetooth Low Energy
RSSI	Received Signal Strength Indication
RFID	Radio Frequency Identification
IoT	Internet of Things
EU	European Union
GDPR	General Data Protection Regulation
FAIR	Findable, Accessible, Interoperable & Reusable

BIMprove project

In the past 20 years, productivity in the European construction industry has increased by 1% annually only, which is at the lower end compared to other industrial sectors. Consequently, the sector has to step up its digitization efforts significantly, on the one hand to increase its competitiveness and on the other hand to get rid of its image as dirty, dangerous and physical demanding working environment. Construction industry clearly needs to progress beyond Building Information Modelling when it comes to digitizing their processes in such a way that all stakeholders involved in the construction process can be involved.

The true potential of comprehensive digitization in construction can only be exploited if the current status of the construction work is digitally integrated in a common workflow. A Digital Twin provides construction companies with real-time data on the development of their assets, devices and products during creation and also enables predictions on workforce, material and costs.

BIMprove facilitates such a comprehensive end-to-end digital thread using autonomous tracking systems to continuously identify deviations and update the Digital Twin accordingly. In addition, locations of construction site personnel are tracked anonymously, so that **BIMprove** system services are able to optimize the allocation of resources, the flow of people and the safety of the employees. Information will be easily accessible for all user groups by providing personalized interfaces, such as wearable devices for alerts or VR visualizations for site managers. **BIMprove** is a cloud-based service-oriented system that has a multi-layered structure and enables extensions to be added at any time.

The main goals of **BIMprove** are a significant reduction in costs, better use of resources and fewer accidents on construction sites. By providing a complete digital workflow, BIMprove will help to sustainably improve the productivity and image of the European construction industry.

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1. Introduction

In Architecture, Engineering, Construction & Operations (AECO) industry, optimization in resources, facilities management and proper project coordination is vital to predict and minimize associated risks. Therefore, information sharing plays significant role for organizations working in this sector [1]. BIM is acronym of "Building Information Modelling" and is defined as modelling technology and associated set of processes to produce, communicate, and analyse building models [2]. It can be used as a method to digitalize and establish coordinated flow of information among several stake holders in the industry. BIM helps in avoiding clash & collision, monitoring progress and resource tracking in construction process [3]. BIM data can be exchanged using an open standard like IFC (Industry Foundation Class). It is a data format specially created to facilitate interoperability between different software of BIM. Such format allows the inter-exchange of an information model with minimum loss of data [4]. By use of IFC models in BIM it is possible to exchange and share real time design information.

However, with BIM only it is difficult to generate information related to actual status of resources and facilities used in construction sites in real time (e.g., Digital Twins). Therefore, devices that are capable of enabling communication between things that are existent in real life or virtual can be utilized to generate and consume information. Such approach of focusing on state of "things" and on informing "things" about other things can be achieved by use of Internet of Things (IoT) devices [5]. Integration of such technology for real time data analysis with BIM can be advantageous for various application to improve construction and operational efficiencies [6].

The aim of this document is to provide an overview of the regulation on Digital Twin data sources, which may be limited due to legislation and/or personal data protection.

In Chapter 2, a state of the art with relevant available technical solutions is provided and discussed in detail, followed by Chapter 3, where the legislation background is presented. Chapter 4 highlights the results from the 3 pilot use-cases analysis with the possible scenarios.

2. Technological premises

In [1] authors introduce IoT approach that integrates environmental and localization data in a cloud-based BIM platform to keep records of actual performance data sets. Here the test subjects/workers are provided with hard hats (Helmets) equipped with Avent's Visible Things Bluetooth smart sensors that can collect various environmental data like illumination, temperature humidity etc. For location tracking Accent systems iBKS105 BLE (Bluetooth Low Energy) beacon using Eddystone protocol and RSSI measurement for distance estimation is implemented. BLE device sends advertising events containing identification numbers, sensor data or short web address and waits for connection request from smart devices. RSSI determines the signal strength of the connected device for location tracking and the theoretical distance to the device can be approximated using path loss model [7].

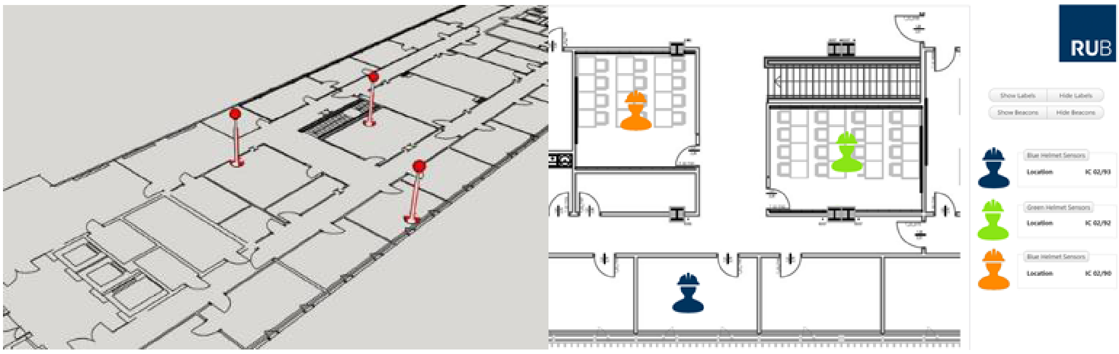

Figure 1 Position of BLE beacon and workers on a BIM plan [1]

The combined data on worker location and environmental data was used for safety assessment around workstations and take necessary preventive measures (as shown in Fig. 1). The data for location tracking was stored and analysed using IoT platform of Thingworx[1] while for environmental data Microsoft's Azure cloud-based platform was used. BLE beacons installed in workstation transmits the signal when the workers with sensor enhanced hats are within the range. Smartphones enables transfer of these data to IoT- Cloudbased platform for data processing. Thus, by combining the personnel's location and timestamp data, it is possible to collect and visualize presence and duration of workers in workstation through IoT-BIM platform.

Similarly, in [3] authors investigate BIM & cloud enabled RFID indoor localization system. It consists of RFID readers, antennas, and tags as sensing devices. The tools include 2 RFID readers (Astra-NA & Mercury 6) strategically placed around the sensing area to read tags on the subject to be localized, three types of RFID antenna (compatible with readers) to read data from tags and transmit the collected data to computer for further data processing via reader, Passive tags (using radio energy emitted by readers) mounted on helmets of the workers, Wi-Fi router for transmission of data

[1] https://www.ptc.com/en/products/thingworx

from the readers to computer & cloud server and a computer with monitoring & alert program for configuration and calibration of the system in emergency cases.

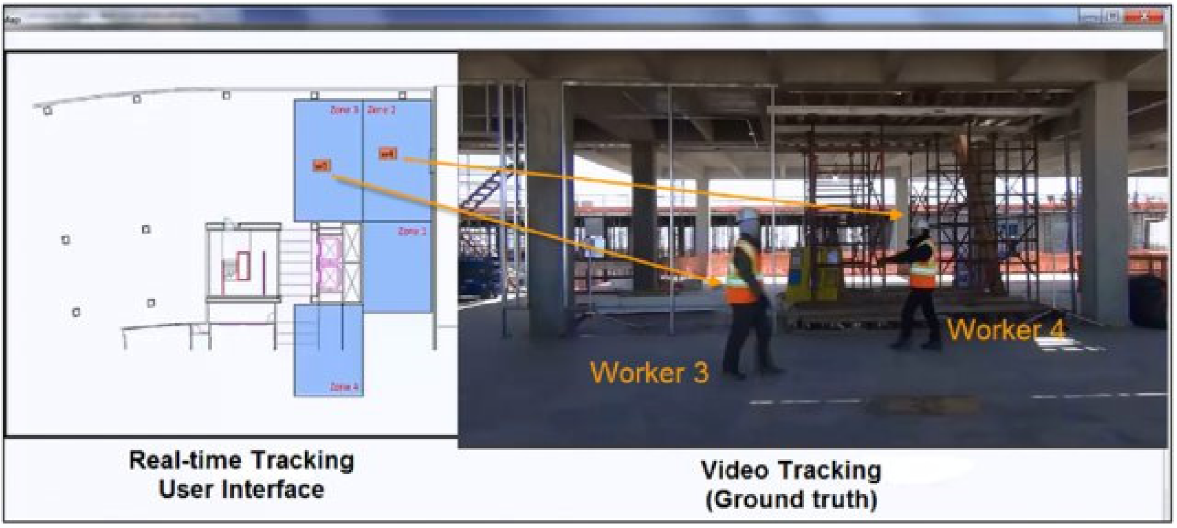

Figure 2 RFID based tracking and comparison [3]

The tag information is collected by RFID antennas through radio waves. This raw sensing data includes tag number, entry time stamp, received signal strength indication (RSSI), antenna ID etc. RSSI gives the proximity of the tag from the antenna and locates the subject to predefined zone based upon its proximity to antenna. The location of antennas is provided to BIM database and 3D BIM model in visualization application is integrated to cloud computing system that provides contextual location visualization (as shown on Fig. 2). The field test of the system showed that it was capable to locate the subjects in real time with 88.1% accuracy, 84.7% precision and 89.6% efficiency.

Likewise, in [8] BIM & IoT integrated technology is used for fire prevention & disaster relief system. It makes use of fire sensors, based on Bluetooth technology that provide information on temperature, smoke conditions and personnel locations in an indoor environment.

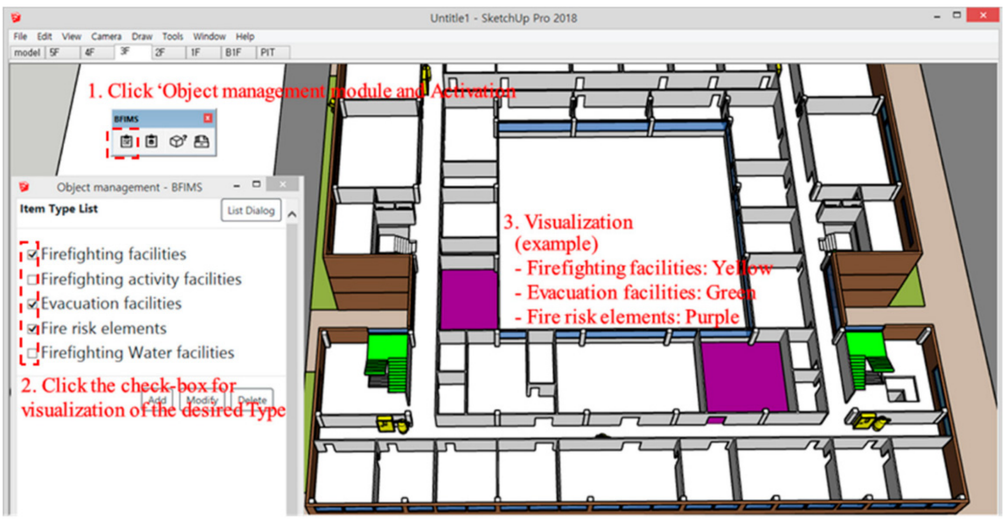

Figure 3 Visualization of fire prevention & disaster relief system [8]

The information is integrated to BIM based system for 3D visualization (shown on Fig. 3). Such integrated system is deployed for early detection of fire, its point of origin & spread, and provides guidance to personnel inside the buildings based upon their location to support the evacuation and rescue works. To access personnel localization data mobile app is used. The app makes connection to the fire sensors via Bluetooth and captures its broadcast information such as RSSI, sensor ID etc. These signals are uploaded to the server and are used to determine the location of the sensor or app based upon corresponding strongest RSSI, sensor ID in BIM component, and mobile device ID.

3. Legislation premises

Data can be divided into two different categories: research data and personal data.

3.1.1. Research data

Research Data are include registrations, notes, reports in the form of numbers, texts, images and sounds that are generated or occur during a research project.

Better access (open access) to research data strengthens the quality of research, because results can be more easily validated and verified, and because data can be used in new ways and in combination with other data.

Not all research data should or can be shared. Reasons not to share research data may be:

- *Security considerations*: If the information threatens individuals or national security, then data should not be made publicly available.
- *Personal data*: The applicable privacy rules must be observed at all times.
- *Other legal matters*: If the provision of data is contrary to other legal provisions, you must not share (rights / IP / duty of confidentiality).
- *Commercial conditions*: Data that has commercial value can be exempted from the requirement.

3.1.2. Personal data

Personal data includes any information about an identified or identifiable person, such as name, address, e-mail address, photos, fingerprints, and social security number.

Some personal data is considered sensitive. This primarily applies to information about ethnic background, political, philosophical, or religious opinion, that a person is suspected, charged, indicted, or convicted of a criminal act, sexual orientation or orientation, trade union membership, health information or health conditions, genetic or biometric information for identification of person.

If something is done with the personal data, for example that it is collected, used, stored and possibly handed over to others, then this constitutes a "processing" of personal data. Processing of personal data requires a basis for processing.

3.2. FAIR

Research data, should be shared based on the FAIR set of guiding principles[2]:

- **F** - Findable
- **A** - Accessible
- **I** - Interoperable
- **R** - Reusable

3.3. GDPR

General Data Protection Regulation (GDPR) is a regulation in EU law on data protection and privacy in the European Union and the European Economic Area. Privacy is about the right to decide over your own personal data. The individual must, as far as possible, be able to decide on his or her own personal data. The rules for processing personal data are based on some basic principles. The principles are set out in Article 5 of the EU Privacy Regulation[3]. Other provisions in the EU Privacy Regulation are based on these.

All processing of personal data shall take place in accordance with these principles which are:

a. **Legal, fair and open processing**: there must be a law (a legal basis) which allows the processing of personal data. At least one of the principles set out in the EU Privacy Regulation must be met. The processing of personal data shall be done in respect of the data subjects' interests and create trust. The processing of personal data must be comprehensible and predictable for the data subject, so that he or she can adapt and be given the opportunity to assert his or her rights. Transparency about treatment is a prerequisite for individuals to be able to safeguard their rights and interests.
b. **Purpose limitation**: personal data shall only be processed for specific, explicit, stated and legitimate purposes. Personal information may not be reused for purposes that are incompatible with the original purpose. Further processing for archival purposes in the public interest, for purposes related to scientific or historical research or for statistical purposes is considered compatible with the original purposes. This presupposes that technical and organizational measures have been introduced to ensure the data subject's rights, in particular to ensure that the principle of data minimization is complied with. Relevant measures may include pseudonymisation. If the measures can be fulfilled by further processing that does not make it possible to identify the data subjects, the purposes must be

[2] https://www.force11.org/group/fairgroup/fairprinciples
[3] https://eur-lex.europa.eu/eli/reg/2016/679/oj

fulfilled in this way (anonymisation of the personal data). Further processing presupposes that the EU Privacy Regulation has been complied with in the original collection of personal data.

c. **Data minimization**: the amount of personal data collected shall be limited to what is necessary for the purpose of the collection.
d. **Correctness**: personal data that is processed must be correct and must be updated if necessary.
e. **Storage restriction**: personal data shall be deleted or anonymised when they are no longer necessary for the purpose for which they were collected, unless the personal data is subject to archiving (i.e., is included in documents that are subject to case processing and have value as documentation).
f. **Integrity and confidentiality**: Which means that the data controller at the given organization must take measures against unintentional and illegal destruction, loss and alteration of personal data. This should take precedence over availability.
g. **Accountability**: Organizations shall act in accordance with these principles and ensure that the rights of the data subjects are safeguarded. Organizations must be able to document that the company has implemented the necessary organizational and technical measures to comply with the EU Privacy Regulation.

4. BIMprove Digital Twin data handling in the pilot use-cases

The following table (Table 1) have been established for handling both research and personal data. Please note, that data sources in the provided table are only dealing with dynamic data sources, e.g., sensory information, and do not address static models (BIM) of the building asset.

Table 1 Overview of research and personal data to be collected/handled

Group name	Data source	Classification
Geolocation (Real Time)	Workers	Personal data
	Trucks	Research data
	Machinery	Research data
Workers personal data	Role	Personal data
	Company / Subcompany	Personal data
	Image (photo)	Personal data
Trucks data	Function	Research data
	What Transport	Research data
	Company / Subcompany	Research data
	Plate number / ID	Research data
Machinery data	Function	Research data
	Plate number / ID	Research data
	Company / Subcompany	Research data
Sensors data	Fire related	Research data
	Waste related	Research data
Geometry data	Scanner	Research data (if presented in processed form)
	Camera	Research data (if presented in processed form)

The classification of the data sources is based on the aforementioned categorization presented in Chapter 3. It is important to highlight, that the categories falling under the personal data are not including any sensitive personal information as discussed in Chapter 3.1.2, meaning that with a written consent from the data owner (e.g., worker), the data could be stored analysed and processed.

The information sources specified in Table 1 are analysed in the pilot use-case based on the following possibilities:

a) Anonymized Capture: only applicable to category Geolocation (Real Time)
b) Capture / Store: not applicable to category Geolocation (Real Time)
c) Anonymized Visualization: only applicable to category Geolocation (Real Time)
d) Visualization: not applicable to category Geolocation (Real Time)
e) Merge/join stored data with other sources
f) Create statistics / benchmarking
g) Limited Access (By project Role)

h) Cloud store (Europe)
i) Rights on data (Owner)
j) Responsible (Who authorized the capture)

The above-mentioned possibilities are further refined with respect to expected outcome of the analysis:

a) Requires specific permission from responsible/owner
b) Don't require any specific permission from responsible/owner

Table 2 shows an example combination of the analysis and data source options.

Table 2 Connecting data sources to processing/storing

Group name	Data source	Anonymized Capture	Merge/join stored data with other sources
Geolocation (Real Time)	Workers	*Requires specific permission* or *Don't require any specific permission*	*Requires specific permission* or *Don't require any specific permission*
Machinery data	Plate number / ID	N/A	*Requires specific permission* or *Don't require any specific permission*

In all three pilot use-cases, the industrial partners of the BIMprove project have filled in the questionnaire based on the local regulations and possibilities. A sample of the questionnaire is shown on Fig. 4.

		Anonym Capture	Capture / Gather	Anonym Visualize	Visualize	Merge/join data with other sources	Create statistics / benchmarking	Limited Acces (By project Role)	Cloud store (Europe)	Rights on data (Owner)	Responsible (Who authorize capture)
Geolocalize (Real Time)	Workers										
	Trucks										
	Machinery										
Workers Personal Data	Role										
	Company / Subcompany										
	Image (photo)										
Trucks data	Function										
	What Transport										
	Company / Subcompany										
	Plate number / ID										
Machinery data	Function										
	Plate number / ID										
	Company / Subcompany										
Sensors	Fire related										
	Waste related										
Geometry	Scanner										
	Camera										
		Requires Specific permision / Dont require specific permision	*Requires Specific permision / Dont require specific permision*	*Requires Specific permision / Dont require specific permision*	*Requires Specific permision / Dont require specific permision*	*Requires Specific permision / Dont require specific permision*	*Requires Specific permision / Dont require specific permision*	*Requires Specific permision / Dont require specific permision*	*Requires Specific permision / Dont require specific permision*	*General Contractor Subcontractor Client Worker ...*	*GC Legal department Client Subcontractors Workers ...*

Figure 4 Pilot use-case questionnaire

While all information needed for the BIMprove Digital Twin could be collected, with an explicit written permission from the data owner (e.g., worker), the collection and more specifically labelling the data, who it belongs to, poses computational challenges, which in a later stage could imply also ethical challenges.

An example could be a foreman on a construction site, which has given a written consent to record his/her location and to run analysis based on the location on the construction site. While only the storage of location should not cause any serious ethical challenge, the analysis, e.g., production ratio/efficiency of the worker, may interfere with the original purpose of the data collection consent. As soon as the foreman would receive a negative feedback based on the analysis, the first thing would be from his/her side to withdraw the consent, as this is his/her constitutional right (see Chapter 3.3), resulting that the analysis is invalid.

To address such challenges, the only viable solution is the anonymized capture/storage of the location data for the workers. This can be solved in different ways, e.g., described in Chapter 2 and some recent work of [9]. In relation to tracking and observation, the BIMprove project implements the FAIR principles for data storage, in a sense that any stored data is pseudo anonymised, in order to protect private concerns of interactors of the BIMprove system, and that explicit endpoints will be specified for accessing the data which then can be reused externally. The pseudo anonymisation and transparency confirms to the General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679) of the European Parliament which aims at strengthening the right of citizens to self-controlling their personal data. In addition to the above-mentioned data processing and storage, the sensor data processing happens closest to the data source and only forwards high-level, extracted and anonymized data to data storage or further processing.

The most promising solution is a BLE zone-based setup, as shown on Fig. 5. To build up such a system an infrastructure based on gateways, repeaters need to be established on the construction site. All workers/machines/trucks require a small BLE tag, which is assigned to them randomly.

Figure 5 Zone based localization of workers/machines/trucks

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