WARSAW UNIVERSITY OF TECHNOLOGY Index 351733
FACULTY OF CIVIL ENGINEERING
COMMITTEE FOR CIVIL AND WATER ENGINEERING
POLISH ACADEMY OF SCIENCES ISSN 1230-2945

DOI: 10.24425/ace.2026.157494

ARCHIVES OF CIVIL ENGINEERING

Vol. LXXII ISSUE 1 2026

pp. 597 –615

Research paper

Implementation of the digital CDE platform for managing real estate in operation

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Abstract: In civil engineering, information systems are increasingly being utilized, particularly Building Information Modeling (BIM) technology. BIM is currently most prominently used in the design and construction phases, with less intensity observed in the implementation of solutions in later phases of operation and/or demolition. However, these issues mainly concern recently constructed objects, for which a digital twin was created at the design stage, greatly facilitating the decision-making process for managers to implement such solutions. In this article, the authors focus on presenting an example of using the Common Data Environment (CDE) platform for managing an existing building, for which 3D documentation was not created in earlier stages of the lifecycle. For analysis and as an attempt to implement the use of BIM technology, building D-2 located on the AGH campus was selected. Virtual documentation in the form of a “digital twin” was prepared for the selected object. The traditional and currently practiced property management plan was analyzed. Firstly, a plan for repetitive tasks was presented, including required building inspections and cyclical work performed. Subsequently, a process of action in case of a selected failure was developed. The traditional management plan was compared with the one prepared using the digital platform. The advantages and disadvantages of each solution were identified, and the validity of introducing process improvement for building administration using the selected tool was verified.

Keywords: BIM (Building Information Modeling), CDE (Common Data Environment), digital platform, digital twin, management, operation phase

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1. Introduction

In the construction industry, we have been witnessing a dynamic digitalization trend for several years, gradually being introduced into all phases of the building lifecycle [1–3]. Currently, the greatest progress is mainly observed in the design and implementation phases, although increasing attention is also being paid to the use of digital solutions in the operation and/or demolition phases of the building [4–6]. In this article, the authors focus particularly on the possibilities offered by Building Information Modeling (BIM) technology in the context of the seventh dimension of BIM, which is the operational phase of the object. In the face of dynamic digitalization development, the construction industry is not lagging behind, and the market is seeing an increasing number of tools and systems aimed at streamlining the management of the entire building lifecycle [7, 9]. It is worth mentioning the information systems, including Common Data Environment (CDE) platforms, which are an important supporting element in object management processes.

In the presented research study, a combination of two methods was utilized: a literature review and an implementation project. In the literature review, we conducted a systematic review to identify the challenges and limitations of implementing CDE in the operational phase and to investigate the latest research trends. Specifically, the Scopus, WoS, and ResearchGate databases were searched. Advanced search strings using Boolean operators were employed with keywords such as facility management, CDE, management systems, management efficiency, property management, BIM implementation, and BIM management. The literature review indicated a limited number of publications on the implementation of CDE platforms in the operational phase of real estate [10]. Practically no examples of CDE FM platform implementation analysis in Poland were found, which results from the relatively short time it has been on the market and the lack of familiarity among managers with its potential. After screening the initial search results, we reviewed abstracts and, where relevant, full-text articles to extract key data points. This systematic review provided a foundation for understanding the challenges and potential solutions related to CDE platform implementation, guiding our empirical research and informing the context of this study. Regarding the building located on the AGH campus, we employed a qualitative approach to collect empirical data through semi-structured interviews with stakeholders, which allowed us to supplement the data concerning the case study. These stakeholders included property manager, technical staff, and maintenance personnel, all of whom had varying levels of familiarity with the CDE platform. The interview questions were divided into three main categories: challenges in implementing the CDE platform, perceived benefits of using CDE in building management, and recommendations for improving platform efficiency. The interviews were conducted over several weeks, with each lasting several dozen minutes. After data collection, we employed thematic analysis to identify recurring patterns and insights from the interviews. This approach allowed us to group similar responses and draw conclusions regarding the effectiveness of the CDE platform.

It is also worth noting that managing a building during the operational phase is becoming increasingly complex and demanding. With technological progress and growing expectations regarding efficiency and user comfort, it is necessary to use modern tools that will enable effective property management. In this context, the digital platform becomes an extremely valuable tool that can significantly facilitate and improve processes related to building operation. This article will discuss the possibilities offered by the use of a digital platform in building management during the operational phase. The benefits it can bring to property managers will be presented, as well as the functionalities and solutions available on the market to meet the growing requirements in the field of property management.

2. Property management according to regulations

The buildings constructed based on building permits typically require continued documentation of activities carried out in them during the subsequent phase, which is their operation. The authors of the article focus on these types of buildings. In such structures, the successor to the Construction LogBook (CLB) [11], after the facility is put into use, is the Building LogBook (BLB), where all events occurring in the facility must be recorded. Among them, the following groups of activities can be distinguished:

- regular, legally required construction inspections and reviews, especially annual and five-year inspections of both the technical condition of the structure and all installations within it,
- activities related to ongoing maintenance and repair,
- activities related to any refurbishment, modernization, as well as planned works: reconstruction, expansion, and superstructure.

Entries in the BLB can be made by any person authorized to do so, who may or may not possess construction knowledge for this purpose. However, inspections and works, especially those requiring the execution of a project and relevant calculations, should be carried out by individuals with the appropriate qualifications, technical knowledge, and skills [11–13].

The operational period constitutes the longest stage in the life cycle of buildings. During this phase, as stipulated by the Building Law and regulations [14], there is a need for regular collection of information concerning the technical and functional condition of the building [12]. Typically, these tasks are planned and coordinated by the owner or property manager. The manager is responsible for updating the Building LogBook and ensuring the maintenance and repair of the facility [14]. So far, these duties have required significant effort from the property manager, who had to oversee the condition of the building, organize regular inspections of building elements and installations, monitor warranties for various devices, plan work related to necessary repairs, and register user reports regarding any defects in the facility. Additionally, it necessitated the maintenance of extensive documentation, both in paper and electronic form, including protocols, notes, and photographs. Moreover, it required complex planning of the schedule for maintenance and use of the building. These actions are conducted on multiple levels, making it easy to overlook certain obligations, the consequences of which will be noticeable over the course of many years of use.

3. BIM and digital twin in the operation phase

BIM involves collecting and shaping data in such a way that the model provides a comprehensive view of the designed building, its construction, as well as its future operation and decommissioning phase. The created three-dimensional model serves as the basis for building an information model, which will contain data beyond the geometric description of the object, including its physical parameters.

Currently, BIM dimensions are defined from 3D to 10D, with dimensions up to 6D referring specifically to the design and construction phase, providing a comprehensive view of building information along with an analysis of its impact on the environment [15–17]. Meanwhile, the subsequent BIM dimensions, from 7D to 10D, relate to (or encompass) the longest phase of the building's life cycle, the operation phase. In particular, the seventh dimension concerns property management, which is the focus of the authors in the article.

The target stakeholders of BIM 7D are building administrators, property managers, and technical departments of companies. The daily tasks faced by property administrators include:

– coordinating the maintenance of the Building LogBook (BLB) along with necessary regular technical inspections,
– planning the usable area of the building, both internally and externally,
– ensuring the good condition of the building's equipment, commissioning necessary inspections of installations and machinery, delegating repair work in case of malfunctions,
– managing inventory resources, conducting periodic inventory of fixed assets.
– preparing records of income and expenses generated by the investment,
– supervising employees working in the facility, delegating tasks to direct subordinates, and hiring external contractors such as cleaning companies,
– handling tenants of the building, including compiling tenant lists, preparing lease agreements, direct communication with tenants, and addressing ongoing issues.

In management utilizing BIM technology, it is beneficial to utilize a previously prepared 3D model expanded with data related to the operation of the facility, referred to as AIM (Asset Information Model). Documentation such as warranties, inspection records, equipment manuals, etc., is imported into the model. The aim of creating AIM is to segregate information relevant to the facility's operation while archiving the remaining data used in previous phases (if BIM technology was utilized in previous phases).

The concept of digital twins involves directly replicating a given object, considering as many features as possible throughout its life cycle [18–22]. An existing object is referred to as the Reality Twin Model (RTM), while the digital model is known as the Digital Twin Model (DTM). DTM is intended to serve as a database of the building and its equipment, installations, and systems, including their technical specifications, inspection records, maintenance schedules, and facilitating renovation works [23–25]. Additionally, DTM is envisioned to provide a space for analyzing proposed ideas and their associated time and cost reactions post-implementation. Property managers can compare simulated solutions and select optimal ones based on their relevant criteria. Furthermore, ongoing monitoring of the building's technical condition allows for prompt detection of potential issues and failures, enabling timely action that positively impacts the facility's longevity.

Achieving the goals of a digital twin through a digital model is possible if it is continuously updated. Therefore, various methods are employed to create and monitor digital twins. The primary method involves converting flat drawings into a 3D model, supplemented with data from a facility inventory. This is particularly important if such a model was not created in preceding phases of the life cycle.

With an existing BIM model of the facility, various techniques can be applied to facilitate continuous model updates and real-time data logging. Examples include:

– sensors deployed within the facility to monitor parameters such as structural deflections,
– laser scanning,
– AR and VR techniques.

Furthermore, data contained in virtual models can be integrated with systems such as Building Management Systems (BMS) or Computerized Maintenance Management Systems (CMMS). Behind the technology of creating digital twins lies a deeper concept of replicating the real-world state of the surrounding space to create smart cities. The overall effort of transferring reality into the virtual world aims to extend the lifespan of building structures and enable timely reactions and "anticipation of reality" [8, 26].

It is a fact that the operational phase of a building is the longest in its life cycle. Currently, buildings are designed for a minimum operating period of 50 years, whereas the design and construction phase typically lasts several years. Therefore, when creating building models, it is important to consider their operation and realize that the model may be utilized for a long time and updated multiple times [12, 27].

4. CDE platforms and their requirements

4.1. CDE platform

Information models of BIM (Building Information Modeling) for construction objects are complex, multidimensional models developed at different times and by specialists forming a multidisciplinary team. Creating a cohesive and compatible whole from so many components requires ongoing exchange of project information among individuals working on it, as well as drawing information from a single, continuously updated database. Meeting these requirements are Common Data Environment (CDE) platforms, which, when integrated with BIM models, significantly facilitate construction and management processes [1, 28–30].

The CDE platform, as a cloud-based IT solution, is based on information containers and the metadata contained within them. A set of data containers forms a comprehensive information model. An information container is defined as "a team-related, specific, durable set of information retrievable from the file memory hierarchy, system, or application" [30, 31]. It is precisely the organized structure of data storage about the model that makes access to specific information easy, more efficient, and available to all project participants. Centralizing data storage within the CDE also reduces the risk of data redundancy and ensures access to an up-to-date information repository. The CDE platform also serves as a universally accessible means of communication for all participants in the construction process, replacing other information technologies such as email or telephone communication. However, it is worth noting that the initial transition from conventional communication methods is often met with considerable reluctance [27, 31].

Due to the considerable chaos associated with the lack of standardization of requirements related to the rapidly evolving BIM technology in recent years, a series of ISO 19650 standards have been developed, containing descriptions of information management throughout the lifecycle of a construction object [29, 30].

According to the standards described in ISO 19650, a CDE platform should:

- be accessible to all participants in the construction process, but each entity should have access only to the information essential for them,
- ensure easy utilization and retrieval of specific project information through structured information containers and metadata, along with assigned identifiers,
- enable the development of individual information containers by a single task team,
- filter data entered into the platform, manage their lifecycle from implementation on the platform to archiving,
- distinguish four areas for information flow: work in progress, shared, published, and archived,
- undergo periodic updates and automatically notify users,
- record the change history in documentation and model, compare documentation versions before and after changes,
- enable reporting and data analysis, such as work progress, progress of reported collisions and failures,
- be a cyber-secure environment, protect sensitive data, ensure secure data sharing without compromising content integrity [29].

CDE platforms can be used as early as the design phase, and the earlier we start working in one environment, the sooner we will notice the benefits of its use. The characteristics outlined in the standard indicate that the platform is primarily aimed at ensuring constant data updates, document circulation, and communication in a unified environment, and above all, it should be cyber-secure during its use.

4.2. Data implementation into the CDE platform

The process of implementing data is conducted through four work areas on the CDE platform, the schematic of which is illustrated in the graphic (Fig. 1).

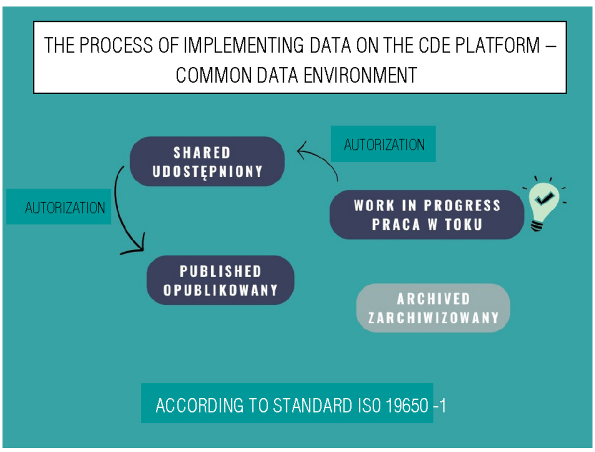


Fig. 1. The process of implementing data on the CDE platform involves four sequential areas. Source: Own elaboration, based on [29]

The first area of information processing on the CDE platform is *work in progress*. It is a state of “*work in progress*" used for the work of the assigned task team, which inputs data and is in the process of processing it on the platform. Data in this state should not be visible to other platform users. The assigned task team should input data onto the platform in accordance with the adopted standard of information implementation and ensure that the data entered on the platform maintains consistency and coordination with other data, such as aligning flat drawings with the model.

textls[-20]The next stage is the check and approve type transition, carried out within the task team. The team verifies and compares the imported data with the project’s information delivery plan and analyzes compliance with established standards, methods, and procedures for generating information.

If a particular information container passes the verification successfully, it receives the status of *check* and subsequently *review*, and is then transferred to the shared area. This is a cooperation area, meaning that the given information container is shared outside the previously assigned team. In this area, the document is verified by other specialists, and any changes or collisions are identified. If editing is required, it returns to the “work in progress” state. Once it is complete, it is made available in the *published* state, where approved data reside.

The *archived* state is used for storing a full register of all replaced data that have been shared and published in the information management process. Data in the archived state are those that were previously in the published state and contain information that was more useful at the previous stage of the project. For example, during the exploitation phase, data needed from a project and execution perspective are archived, as they do not provide key information about the object at a given time. During the operation phase, we will be interested in information related more to machine servicing or space management, rather than those from which we could read, for example, dimensions and spacing of wall reinforcement [29].

In the subsequent part of the article, we conducted a comparison of traditional management methods with digital approaches, focusing on aspects such as implementation time, efficiency, and, to some extent, costs. We analyzed data from the case study, which we primarily obtained from the university’s technical sector and the building manager/caretaker. Obtaining more precise quantitative data is not possible at such an early stage of implementation; however, in the future, we would like to analyze multi-year data and compare it concerning the two management approaches.

5. Implementation of the CDE platform on the selected object

5.1. Description of the analyzed building

The object for which a digital twin has been created is a facility located on the AGH campus, commissioned for use in 2020, named D2 (Fig. 2). It is used by the Faculty of Electrical Engineering, Automatics, and Biomedical Engineering (WEAIiIB) and the Faculty of Drilling, Oil and Gas (WNiG). Its main function is educational for students, but it also serves administrative and office purposes for academic staff. Access to the building is provided from ground level on the north and east sides. On the ground floor, there is a porter's lodge through which access to the building is controlled. Vertical circulation is provided by a centrally located double-flight staircase and a passenger-goods lift. The facility also features a hydraulic scissor lift for introducing heavy laboratory equipment and testing passenger cars into the laboratory on the basement and ground floors [32].

Fig. 2. View of building D-2 from pavilion A-4, AGH, photo from own archive 20.10.2023

Building D-2 is a six-storey volumetric structure, consisting of one underground level and 5 above-ground levels, constructed in a monolithic design. The building is equipped with water and sewage installations, technological sewage installations, central heating, gas, mechanical ventilation with cooling, technological exhaust ventilation, electrical and low-current installations including SSP, and technical gas installations. Additionally, the building has a geothermal heating system based on heat pumps. Among other innovative solutions, the building features an electronic access card system for room entry, coupled with BMS maintenance system installations, as well as monitoring [32].

5.2. The aim of managing the presented property

The D-2 facility serves as a public building primarily for educational purposes, catering to students and academic staff. The objective is to maintain continuous access for users, especially during academic sessions. It is crucial to ensure comfortable and safe conditions for conducting classes and work activities. This includes maintaining a conducive environment characterized by cleanliness, minimal noise, and functional equipment, particularly in laboratory settings. During the autumn and winter seasons, room temperatures in heated areas should range between 20–24°C. Additionally, it is essential to ensure the efficiency of electrical, water supply, sewage, and ventilation systems. Emphasis is placed on adequate air circulation to prevent microbiological issues, necessitating regular maintenance, humidity monitoring, proper ventilation, HVAC system cleaning, and indoor air quality control. Prompt action is required to address any issues, especially concerning combustion engines in laboratory areas.

5.3. The current approach to facility management

The basis of the current traditional approach to facility management involves maintaining a comprehensive set of project documentation, warranty cards, and inspection records in hard copy format, which are stored directly in the University's Technical Department for the analyzed facility. The building falls directly under the Campus Facilities Administration Section, with the Building and Grounds Administration Department serving as its parent unit. This section is considered the administrator of the subject property. As of December 2023, the staff in this section consists of three individuals, serving as a technical clerk, an independent administrative clerk, and an administrative specialist. Building D-2 has a dedicated property caretaker responsible for addressing any emergencies. There are two supervisors working exclusively in this building, employed on a shift basis. An external cleaning company is hired for routine cleanliness maintenance.

Regular inspections are carried out in the building in accordance with the requirements of the Building Law regulations. Additionally, annual inventories of fixed assets in the building are conducted, and a current inventory of resources such as cleaning supplies and materials necessary for conducting laboratory activities, such as personal protective equipment, chemical reagents, and office supplies, is maintained. In the event of minor collisions or non-disruptive malfunctions that do not interfere with classroom activities or pose communication or evacuation route difficulties, the building is deemed substantially functional, with the necessary repairs made as quickly as possible.

In the traditional management approach of the building, both the schedule of inspections, inventories, and cyclic repair processes are recorded and supervised by the building caretaker. Regarding the cleanliness maintenance tasks, the building caretaker relies directly on the work of an external company hired to perform cleaning services across the entire campus. As for replenishing any stock shortages, such as light bulbs, doorknobs, inserts, pads, screws, and seals, they are purchased once a year with a reserve. If there is a shortage before the end of the year, they are replenished accordingly. The same applies to replenishing small equipment in the rooms where classes are held. In the laboratory, all test tubes, tissues, protective gloves, and whiteboard markers are also replenished annually based on established practices and estimations of their usage during the previous academic year. Any malfunctions or problematic situations are addressed promptly by the designated person. The building caretaker is informed of any breakdowns, alarming symptoms, odors, or sounds by receptionists, security personnel, and other users. Since the building caretaker does not permanently reside in the building, they are notified of any suspicious situations or breakdowns via email or phone, occasionally through verbal communication from staff and users. Upon being informed of a problem, their task is to conduct an initial verification to assess whether it is serious, requires immediate action or repair, or if it is a recurring issue and what actions should be taken based on past occurrences. The building caretaker keeps a record of previous repairs and repair protocols conducted in the building. Subsequently, they contact the person responsible for building maintenance in the main Technical Sector of the university, conveying the essence of the problem with a preliminary solution proposal if possible. The designated staff member is responsible for delegating the repair task to a technical employee or an external company. However, the building caretaker is responsible for the settlement and acceptance of the repair work, including receiving post-execution documentation, which is then archived in the central technical department.

As evident, the key aspect of traditional building management is the building caretaker. They are typically the ones who remember when a particular equipment element needs to be replaced, when inspections need to be conducted, and they keep records and documents related to repairs and inspection schedules. In this case, significant reliance is placed directly on the individual, who provides verified information to the Technical Department.

5.4. Planning cyclical tasks using BIM tools

An alternative to traditional management of building D-2 is to support the respective process using a Common Data Environment (CDE) platform. On the market, there are numerous platforms available for facility management, including Dalux FM, Tandem, PlanRadar, Rezone, and others. Each of these platforms has its strengths and weaknesses. The functionalities of these platforms are similar, indicating an understanding of market needs and competitive monitoring by the software producers. The authors decided to use the solution offered by Dalux due to several years of collaboration with the company and the free provision of a fully functional version of the CDE platform for educational purposes. Additionally, we received full support and assistance during data entry and familiarization with the platform's functionalities from the company's support team.

The Dalux platform, specifically the FM (Facility Management) module, was used for managing the facility during the operational phase. The premise behind employing digital tools in the form of a CDE platform is to generally enhance individual processes. In the analyzed case, the authors focused on the ventilation system installation. Cyclical tasks mandated by building regulations, as well as service works required for usage and wear and tear of ventilation system components, were considered. The problem was centered on the operation of the ventilation system, as examination of the property's room plans revealed that the majority of rooms in the building are laboratory spaces, necessitating the need to maintain the efficiency of the ventilation system, particularly the central unit. To leverage the full capabilities of the platform, it is advisable to create a 3D model of the object beforehand. Thus, based on 2D documentation and a conducted site visit, an architectural-structural and installation model was constructed for the analyzed object. The models were compiled and then implemented into the platform (Fig. 3 and Fig. 4).

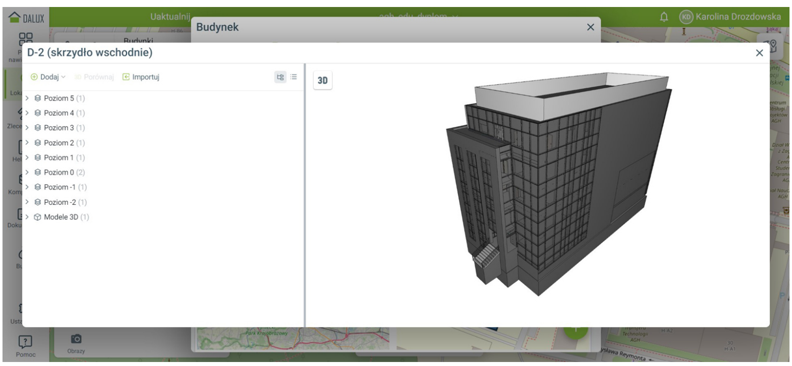


Fig. 3. View of the 3D model in the „Drawings and BIM" tab of Dalux FM system

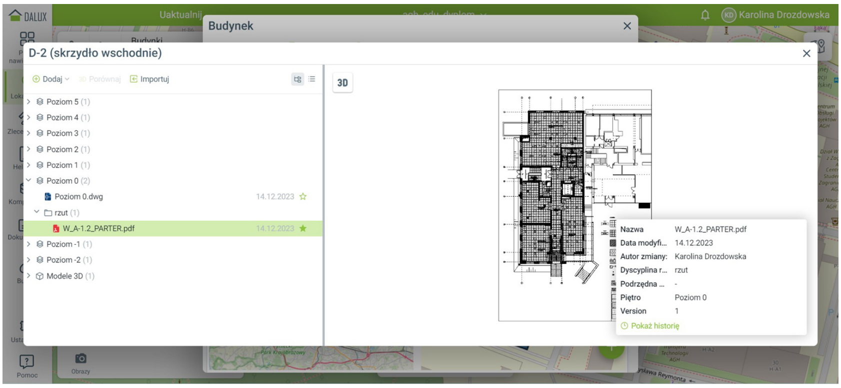


Fig. 4. View in the folder structure of the Dalux FM system, showing the ground floor plan along with the installations located on the suspended ceiling

Proceeding with the implementation of various management activities in the operational phase on the platform, specific tabs were supplemented. Thus, to create a maintenance schedule in the Dalux FM system, the tab for creating recurring work orders was utilized (Fig. 5 and Fig. 6). In this way, the aforementioned cyclical tasks were easily introduced, including inspections of ventilation, electrical, and plumbing installations, replacement of filters in various ventilation systems, periodic cleaning of building premises, and inventory of supplies needed for classes. Additionally, specific tasks were assigned to team members. This process of pre-planning activities allows for verifying the number of tasks assigned to each person and the workload allocated. It enables quick and easy verification of the even distribution of tasks and facilitates adjustments to the scope of responsibilities if needed.

Fig. 5. The window displaying the selected recurring work order – replacement of filters in ventilation duct SW-01

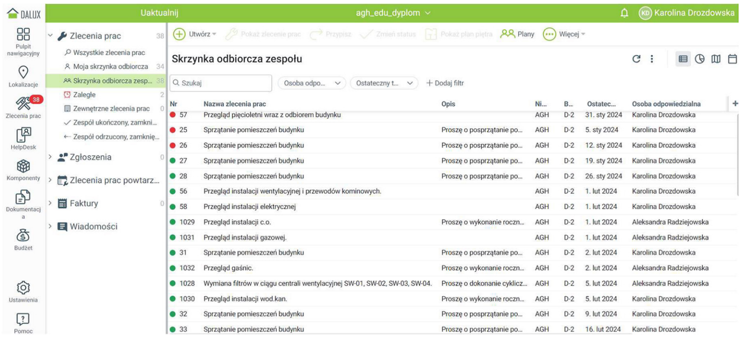


Fig. 6. The team's inbox containing successive recurring work orders. Tasks are assigned to specific team members

5.5. Action in case of a breakdown

Another improvement in the Dalux FM platform is the ability to report breakdowns or any issues directly through the platform (a single communication channel). The system provides a clear and standardized way to make these reports. Using the web version of the system and/or the mobile app, users can quickly report any malfunctions. It was decided to utilize the Dalux FM tab provided for the Technical Department of the building, serving as the property manager, and the Dalux FM HelpDesk application as a mobile app, available for use by university academic staff (those conducting classes) and building security staff (security personnel). The Dalux FM HelpDesk app allows for different levels of access to various platform functionalities. For example, academic staff have access to the process of reporting faults and breakdowns. QR codes have been assigned to each room, which are placed in easily accessible and visible locations. Additionally, a workspace has been prepared and organized so that reports can be assigned not only to specific rooms but also to specific elements/devices. These elements have been correlated with a chosen standardized inventory number. The adopted standardized numbering system is P0_L06_AW_01, which includes the floor number, room number, abbreviated name of the element, and its number based on the occurrence of the element in the room (Fig. 7).

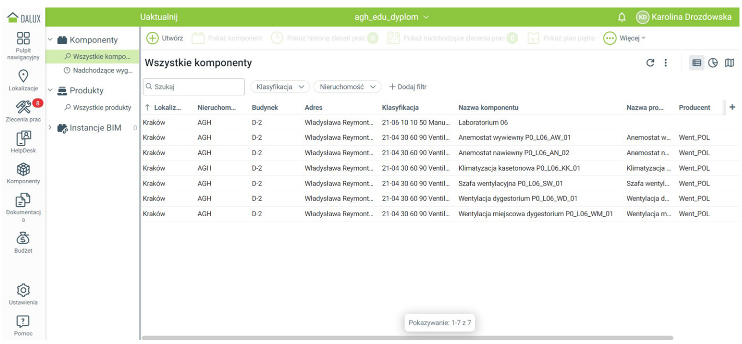
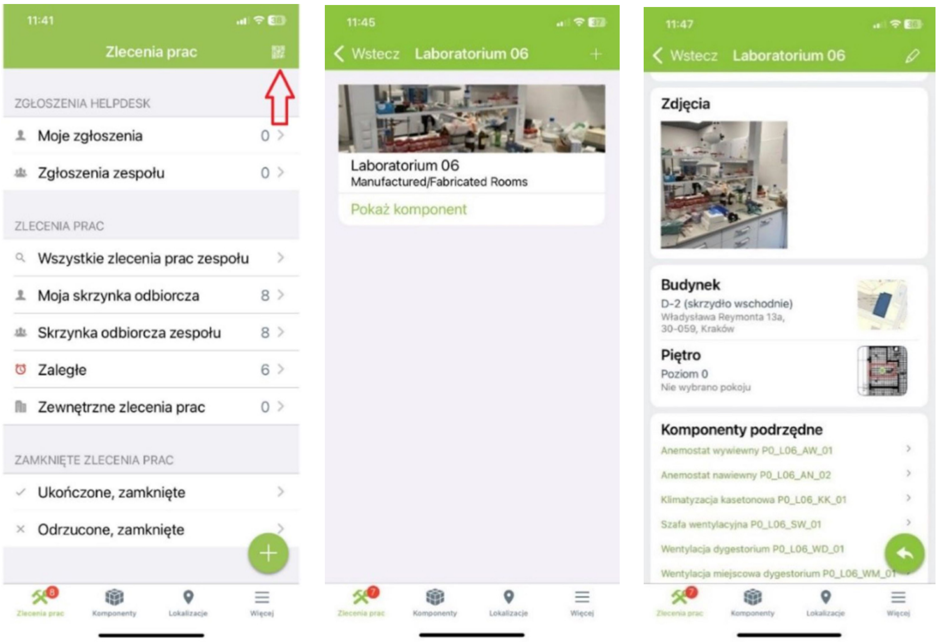


Fig. 7. The "All Components" tab displays a list of entered ventilation components for the selected room in the Dalux FM system

For instance, let's consider a situation where a lecturer notices that the extract air grille in the laboratory is not functioning properly, generating excessive noise. The instructor has the ability to report the issue to the Technical Department quickly and easily using the Dalux FM HelpDesk mobile application. After launching the application, they scan the QR code of the specific room and report the problem to the administrator directly from the mobile app interface (Fig. 8).



(a) (b) (c)

Fig. 8. The interface of the Dalux FM mobile application. In the top right corner of the image, there is a QR code reader (a); Next, there is a view of the recognized component, and further, upon selecting a specific component (b), the data about the component along with assigned subcomponents are displayed in the form of ventilation installation elements (c)

The procedure for handling registered reports is implemented within the platform, where the information about the fault is routed to the person responsible for taking action to resolve it. The individual from the technical sector who receives the report verifies it, and if they deem it necessary, they convert it into a "service order" with the status "service order", assigning it to a specific technical person along with a set time frame for completing the task. They may also prioritize the order. Once the issue is repaired, the technical staff updates the status of the report to "completed". This functioning procedure allows for documenting a comprehensive overview of the situation at each stage of its processing, as well as the response and response time for task completion by the respective individuals.

The advantages and disadvantages of both management approaches are presented in the next section, including features subjectively indicated by the building's users.

5.6. Comparison of advantages and disadvantages of both solutions based on the examined object

As a summary aimed at comparing the advantages and disadvantages of both management methods in building D2, Table 1 has been created.

Table 1. Advantages and disadvantages of two building management methods

Feature	Traditional management	Management using CDE
	Advantages	
Document storage	No need to upload documentation to the cloud space	Centralization, storage in one location with easy access
Ongoing updates	Direct access to and management of documentation without intermediaries	Enables quick response to changes and maintenance of up-to-date property information
Coordination and communication	Familiarity with established procedures	Effective collaboration and communication between different teams and stakeholders
Analysis and reporting	Use of known procedures	Automation of many processes, such as tracking progress and managing documentation, minimizes errors
Costs	No need for investment in expensive software and technologies, lower initial costs	Can prevent significant costs from undetected issues
Implementation	Utilization of familiar methods and processes well understood by the team	Intuitive tool with the ability to assign restricted access to specific functionalities
Integration with existing systems	No requirement	Improves management post-implementation
Data security	Data primarily stored in paper format	Use of appropriate security systems, backups
Flexibility	Ability to tailor management methods to specific needs and requirements	Ability to implement changes and modifications based on the situation
Response to faults and failures	Rapid response in case of familiarity with the manage	Very fast and clear procedure for handling and responding to situations

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Feature	**Traditional management**	**Management using CDE**
	Disadvantages	
Document storage	Fragmentation, various forms and locations of storage, difficulty in locating the correct document	Risk of cloud hacking
Ongoing updates	Lack of real-time updates, requiring multiple updates on various documents	–
Coordination and communication	Complicated, increases the risk of errors and delays in project execution	Reluctance to use the platform for communication
Analysis and reporting	Time-consuming, difficulty in obtaining current data for reports	–
Costs	Long-term need for hiring more staff to streamline management processes	Initial cost of purchasing and implementing the CDE platform can be high
Implementation	Difficulty in onboarding new employees due to the complexity of the existing management system	Time needed to learn how to use the platform and adapt to new processes
Integration with existing systems	Risk of damage, e.g., water damage, fire	Potential difficulty in integrating with existing management systems and software
Data security	Reluctance to change established habits	Potential risks related to data security in the cloud
Flexibility	Potential for long response times, resulting in significant costs due to the damage	Limited permissions for making changes to the platform
Response to faults and failures	Fragmentation, various forms and locations of storage, difficulty in locating the correct document	Requirement for all users to have access to the platform

Analyzing the above tabular data, it can be observed that both solutions have their pros and cons. Depending on the manager's perspective, they may lean towards one of the two discussed solutions. Some of the arguments presented are based on subjective opinions of the evaluators and can be easily refuted.

6. Conclusions

Currently, most large construction companies in Poland use various CDE platforms, but they are mostly used for managing phases earlier than the operational phase. Building models are rarely developed to the extent of BIM 7D, as digitization in construction during the operational phase of a building is a relatively new solution but rapidly evolving. Moreover, construction companies mostly focus on the construction phase and do not deal with the subsequent operational phase of the building, apart from a short warranty period.

The authors focus on the example of implementation at a single facility located on the AGH campus. Currently, ongoing construction projects at the university involve creating digital models of the buildings at the design or construction stage, which will facilitate the future implementation of management for subsequent buildings using the CDE platform. The authors are working on a model and implementation of management using a digital twin for another building, which will be detailed in future publications. Given the public nature of the university, the implementation process is long-term and requires overcoming significant challenges to persuade users of the facility, including both university administration and building managers. Resistance to adopting new solutions is particularly evident among long-term employees who have established their methods for coordinating their work and are reluctant to change proven solutions in their final years of service. However, considering the undeniable benefits of using the CDE platform for building management during the operational phase, it seems to be only a matter of time before this management approach becomes a standard solution.

As illustrated by the presented example, the implementation of the CDE platform faced challenges such as concerns about implementation costs and integration with existing management systems. Further research should focus on analyzing the long-term benefits of using CDE platforms and developing strategies for effectively overcoming encountered difficulties.

Regarding CDE platform management during the operational phase, the largest target group currently consists of building owners or managers. It is obvious that using services offered by companies offering BIM software requires additional financial investment, which always constitutes a major argument against implementing this innovative solution [1, 10, 33, 34].

However, it is worth considering that the use of a digital platform in property management is intended to be a tool to streamline processes and be a convenient, innovative alternative to traditional practices. The tool aims to standardize sources and forms of communication, which should result in shorter response times to occurring failures. The platform, as a repository for storing information, addresses human factors that can lead to missed deadlines, incomplete information, and its loss. The digital tool and the data contained within it are intended to be accessible to a larger number of people and provide ease of retrieving the history of faults or failures of a given element. Furthermore, working with the platform allows for a structured response to all operational activities taking place in the building. From the user's perspective, this provides a sense of security, including through a clear procedure in the event of encountering a problem. From the administrator's perspective, it streamlines and facilitates the coordination of all activities on the property. However, due to the innovative nature of the solution, there is a lack of trust among potential users regarding its use. It represents a change from the previously established and convenient approach, requiring the need to learn how to work with the new tool.

Like many other technological innovations, this solution initially raises many doubts. However, considering the benefits it brings, it is only a matter of time before it becomes a standard in property management processes.

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Wdrożenie platformy cyfrowej CDE do zarządzania eksploatowaną nieruchomością

Słowa kluczowe: BIM (Building Information modeling), CDE (Common Data Environment), platforma cyfrowa, cyfrowy bliźniak, zarządzanie, faza eksploatacji

Streszczenie:

W przemyśle budowlanym od kilkunastu lat obserwuje się dynamiczny rozwój cyfryzacji pracy, który stopniowo wprowadzany jest we wszystkie fazy cyklu życia obiektu. W niniejszym artykule autorki skupiły się szczególnie na możliwościach, jakie oferuje technologia BIM w kontekście siódmego wymiaru BIM 7D, czyli fazy użytkowania obiektu. Na rynku pojawiły się systemy informatyczne, w skład których wchodzą platformy CDE, które stanowią ważny element wspomagający procesy zarządzania obiektem. Platforma cyfrowa staje się niezwykle wartościowym narzędziem, które może znacznie ułatwić i usprawnić procesy związane z eksploatacją budynków. W artykule omówiono możliwości, jakie oferuje wykorzystanie platformy cyfrowej w zarządzaniu budynkiem w fazie eksploatacji. Przedstawiono korzyści, jakie może przynieść dla zarządców nieruchomości oraz jakie funkcjonalności i rozwiązania są dostępne na rynku, aby sprostać rosnącym wymaganiom w obszarze zarządzania nieruchomościami. Platformy CDE mogą być używane już od fazy projektowania, im wcześniej rozpoczniemy pracę w jednym środowisku tym szybciej zauważymy korzyści jakie z jej używania płyną. Cechy, jakimi powinna się charakteryzować platforma wskazują, że przede wszystkim ma ona na celu zapewnić stałą aktualizację danych, obieg dokumentów i komunikacji w jednym wspólnym środowisku i przede wszystkim ma ona być cyberbezpieczna podczas jej użytkowania. Obiektem dla którego utworzono cyfrowego bliźniaka jest obiekt znajdujący się na kampusie AGH oddany do użytkowania w 2020 roku o nazwie D2. Podstawą dotychczasowego, tradycyjnego podejścia do zarządzania analizowanym obiektem jest posiadanie szeroko pojętej dokumentacji projektowej, kart gwarancyjnych oraz kart przeglądów w wersji papierowej, które to przechowywane są, w przypadku analizowanego obiektu, bezpośrednio w Dziale Technicznym uczelni. W przypadku administrowania budynku w wersji tradycyjnej zarówno plan przeglądów i wszelkich inwentaryzacji jak i cyklicznych procesów naprawczych jest odnotowywany i nadzorowany przez opiekuna obiektu. Opiekunowi budynku zgłaszane są wszelkie awarie, niepokojące symptomy, zapachy, dźwięki, prze z pracowników recepcji budynku, pracowników firmy ochroniarskiej jak również pozostałych użytkowników. Opiekun budynku posiada historię wcześniejszych napraw i protokołów napraw przeprowadzanych w budynku, którą sam przechowuje. Kolejno kontaktuje się on, również drogą mailową, bądź telefoniczną z osobą odpowiedzialną za utrzymanie budynku z głównego Sektora Technicznego AGH. Przekazuje istotę problemu z możliwością wstępnej propozycji jego rozwiązania. Zdecydowanie w danym przypadku polega się wprost na danej osobie, która przekazuje do Działu Technicznego już w pewien sposób zweryfikowane informacje. Alternatywą do tradycyjnego zarządzania budynkiem D-2, jaką proponują autorki, jest wsparcie przedmiotowego procesu przy pomocy platformy CDE. Do tego celu proponuje się wykorzystanie platformy firmy Dalux, a dokładniej moduł FM (Facility Management). Wskazano m.in. usprawnienie zgłaszania awarii lub wszelkich problemów bezpośrednio przez platformę (jeden sposób komunikacji). System posiada jasny i ustandaryzowany sposób na dokonywanie przedmiotowych zgłoszeń. Aplikacja *Dalux FM HelpDesk* daje możliwość wprowadzenia różnych poziomów dostępu do poszczególnych funkcjonalności platformy. I tak np. dla pracowników naukowych udostępniony jest proces zgłaszania usterek i awarii. Ponadto do każdego z pomieszczeń przypisano odpowiednie kody QR, które umieszczono w łatwo dostępnych i widocznych miejscach. Przygotowano i uporządkowano również obszar roboczy, tak aby zgłoszenia można było przypisać nie tylko do konkretnego pomieszczenia, ale i elementu/urządzenia. Platforma CDE ma na celu ujednolicenie źródeł i form komunikacji, co ma skutkować skróceniem czasu reakcji na występującą awarię. Platforma, jako że ma stanowić repozytorium do przechowywania informacji, wychodzi naprzeciw czynnikowi ludzkiemu, który może skutkować przeoczeniem terminu, wybrakowanych informacjach i ich utracie. Przedmiotowe narzędzie cyfrowe i zawarte w nim dane mają być dostępne dla większej liczby osób, a także zapewniać łatwość odtworzenia historii usterki bądź awarii danego elementu. Co więcej praca z platformą pozwala wprowadzić ustrukturyzowaną reakcję na wszelkie działania eksploatacyjne odbywające się w budynku. Rozwiązanie to, podobnie jak wiele innych innowacji technologicznych w początkowej fazie budzi wiele wątpliwości, jednak patrząc na korzyści, jakie niesie jej stosowanie, jest tylko kwestią czasu, kiedy stanie się standardem w procesie zarządzania nieruchomościami.

Received: 2024-10-08, Revised: 2024-11-12