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Benefits of Implementation of Common Data Environment (CDE) into Construction Projects

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Abstract. The BIM (Building Information Modelling) is very actual topic of contemporary research in construction management. There are many views how to observe benefits of BIM in construction industry. It is clear that project management and optimization of management processes in construction projects is big challenge nowadays. The purpose of paper is to enhance efficiency of construction management practices. Paper follows up previous papers of authors that were focused on crucial points of construction management from view of structure and hierarchy of construction projects. There were defined crucial points in exchanging information and their insufficiency for concrete participant of construction project. This paper is focused on standardized environment for exchanging information in BIM. Generally, it is called Common Data Environment (further CDE). The paper observes influence of CDE on efficiency of construction projects and options of implementation into real projects. From practical experience of authors in project management in construction business were proposed possibilities of implementation to road projects in Czech Republic from view of feasibility. For several possible types of implementation of CDE (proposed by authors) were evaluated impacts on feasibility of construction projects primarily cost and benefits of implementation. From this evaluation were find out the most appropriate types of implementation for CDE and practical proposal of strategies of implementation of CDE into construction projects of multiple types of construction projects.

1. Introduction

Construction projects and their management are naturally complex and demanding systems. Inappropriate control of the system leads to increasing project costs, project delays, reducing productivity and loss of profit. Crucial point of control projects is delivering of right and actual information to person who does work or process. This requirement is hard to accomplish with increasing complexity of the project. During construction project are produced big amount of differentiate data. The main problem is the data are unstructured, chaotic, poorly coordinated and placed on isolated islands of information. Data are inappropriate to work with them, benefit from them or externalized knowledge from them. It causes workers who create this information chaotically and without structure.

Related to BIM implementation into construction projects there exist effort to standardize this data environment. British Standard Institution created in 2013 code of practice named Specification for information management for the capital/delivery phase of construction projects using building information modelling. It defines types of data and protocols for their exchange. Clearly specified structured data and regulation of exchange enhance reduction of time and costs on co-ordinated information. Providing of CDE processes (data exchange, check protocols) delivers spatial coordination.



2. Principles and processes of CDE according to BSI PAS 1192-2:2013

According to BSI PAS 1192-2:2013 are data of project (so called Asset information model) structured to classes Documentation, Non-graphical data, Graphical model. Process of creating documentation is involved of these steps:

1. Work in progress (WIP) - non – verified design data
2. Approved WIP is authorised in shared area by other specialist designers. It confirms harmony with other models. Approval can consist of many levels of checking (e.g. model suitability check, technical content check, etc.).
3. The documentation publishes for all participants of projects and then it archives.

All of these checks can provide without implemented BIM levels of adoption or computerized design. Nevertheless BIM and IT solutions can speed up exchange of coordinating information and interrelated approvals of the procedure.

Procedures of checks are not described for construction operation, but it should be analogically used for construction operations. Matrix of approvals has to be created thoroughly with respect not to enlarge bureaucracy of project (e.g. unnecessary signatures). Approvals of changes, more detailed project documentation and quality tests should be registered in list of events which should be monitored by project manager regularly [1].

3. State of the art of CDE in contemporary construction road projects in Czech Republic

Construction projects of roads are under control of Czech highway agency. There exist guidelines, which specify documents need to create and to save. Formal view of documents differs for every project. Actual state of saved documents is poorly monitor during project. Documents are finished after action.

Nowadays during construction projects of roads in Czech Republic are created documents according to the structure below. The structure is actual state of digital archives of projects in Czech highway agency. Documents and their structure are constantly under development.

1. Contract documentation
 - Main contract
 - Other contracts
 - Contracts with owners of the land
 - Tender documentation
 - Bid of other bidders
2. Administrative documentation
 - Territorial decision and relevant documents
 - Public proceedings and the statements of the state administration bodies concerned
 - Building permit
3. Guidelines, commands and procedures
 - General guidelines of the owner of construction project
4. Construction diary
 - Only main construction diary (Construction diaries of objects are saved in folders for objects)
5. Finance documentation
 - Billing documentation
 - Change orders
6. Quality documentation
 - List of tests in laboratory
 - Summary list of defects, disagreements and unfinished
 - Technology prescription
 - Control and exam plans
 - Takeover of technological layers
 - Contractor's summary report of quality construction works

- Records from technical inspection
- 7. Geodetic documentation
 - Summary geodetic documentation of project
 - Geodetic measurements
- 8. Engineering activities documentation
 - Handover/takeover site
 - Organizational schema of project (owner and contractor)
 - Mail of project
 - Schedules of works (updated weekly)
 - Approval of materials and suppliers
 - Records from negotiations
 - Harmonogram (long time schedule)
 - Contractor's report about works (update one a month)
 - Report of technical consultant about works (one a week, one a month)
 - Report of safety manager
- 9. Environment
 - Report of BIO/ECO consultant
- 10. Geology
 - Detailed and additional geology research
 - Hydrogeology monitoring
 - Additional geology researches during project (Provided by contractor)
- 11. Information system TEMPUS
 - Photography documentation with metadata (GPS coordinates, name of object, description of photo)
- 12. Records of video monitoring on site
 - It is not yet included in projects. It will evaluate amounts of workers on site and progress of works. It should serve as evidence for dialog between owner and contractor.

These documents are saved in digital archive with specified level of security. Savings of documents are done after authorization of final form of document. Digital archive does not include Work In Progress documents. It is saved on participant's servers. It is related to fully responsibility of participants of projects for saved documents and their correctness.

Up to date documents are provided by regularly recording e.g. one a day. Regular recording depends on frequency of creating of documents and personal liability of workers. Up to date documents are crucial for decision making of responsible persons.

Points 1-10 generally are created in paper form then it is digitized. Even all of approval forms are in paper form and are exchanged and signed manually. It causes additional costs and time on coordination and it can cause errors (lost or corrupted documents – randomly or purposefully).

Points 11-12 are digital by nature and are coordinated with respect to precise control of project. By the way to Tempus and Videomonitoring are inserted big expectations.

4. Impacts of poorly defined CDE and its processes in construction project in Czech Republic

In paragraphs above were described CDE defined in British code of practice and state of art in Czech Republic. From previous research of authors was found out the most negative impacts on construction projects are caused insufficient information. Insufficient information is for instance Defects in project documentation, Deviation of project documentation from reality, Vaguely defined specification of project documentation, Insufficient inspection of performing works, Vaguely define supply system and relations with suppliers, [2].

From analysis of state of art of CDE in Czech Republic and according to British Standards is obvious that negative impacts of insufficient information are solvable by appropriate implementation of CDE to

projects. By appropriate level of development is possible to mitigate failures during creating documentation and construction operations [3]. If the implementation of BIM and CDE have clear effects, it will enhance effort for more complex and deep implementation of BIM to companies and it will increase investments on trainings new BIM abilities [4]. Another steps for better implementation is research on field of methodology process model and modification of BPMN which will allow record activities with multiple roles. [5]

5. Conclusion

Common data environment as described above fulfils definition of BIM maturity level 2. From view of owner (investor) of project implementation of CDE enhance its control functions and in final impact on reducing costs, increasing quality (keeping up all necessary parameters) and reducing time delays. General principles and concepts of CDE are described in **BSI PAS 1192-2:2013**. In Czech Republic it should be aptly adopted to this construction environment. The gap in level of definition of CDE is in concrete data exchange formats and definition of necessary documents for realization of construction operation. There should be initiative from governments to standardize this environment with respect to nature of every project (roads, residential buildings, refurbishment etc.). Road projects in Czech Republic are influenced by very complex legislation, often changing this legislation and complicated structure of decisions and responsibilities of local offices. It is hard to accomplish all conditions in right time. Properly defined Common Data Environment should enhance resilience of construction projects against changes of external environment of projects (e.g. legislation, technical innovation, changing opinions of land's owners in neighbourhood in case of long-term projects).

Another research activity of authors will direct to describe complex definition of Common data environment of construction projects and try to test this environment like dynamical system for better understanding of its behaviour as real system and design optimal architecture for fluent implementation in construction project. Next outputs will include quantitative effects of implementation of BIM and CDE.

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