The importance of data quality within the AEC industry.

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Since its inception humanity has been on the move in search of a better socio-economic living environment. This has led to 3.5% of the global population migrating, of which 31% reside in Asia, 30% in Europe, 26% in the Americas, 10% in Africa, and 3% in Oceania. In 2018, 13% of the global population lived in 33 cities. This included migration from rural-to-urban areas such that cities grow to form urban mega-cities.[1] These migratory flows along with the global population heading towards 8 billion people have led to a growing demand for dwellings, workplaces, educational & recreational facilities. As such the construction industry was valued at $7.8 trillion in 2021 and is expected to grow by 35% in the upcoming decade. To cope with these growing demands 13,000 buildings are being created daily, resulting in a 12% increase in construction activity from 2020 to 2021.[2] This overwhelming demand has resulted in the AEC *(Architectural, Engineering and Construction)* industry evolving rapidly over the past decade. As such the industry has evolved to adopt new processes and project delivery methods while introducing new construction methods, technologies, and sustainable materials.

Figure 1: In 2021 the construction industry was valued at $7.8 trillion and 13,000 new buildings are being built daily to meet current demands.

Evolutions related to process and project delivery methods have seen owners and contractors shift from traditional design-bid-build to design-build projects. As such 58% of owners have already adopted a design-build framework or plan to switch soon.[2] A design-build process allows for projects to complete within budget while being faster, and less risky for the owner and makes communication between the various stakeholders streamlined. This is possible as the process allows for various stakeholders and disciples to work simultaneously.[3] In relation to new construction methods, brick and mortar are being replaced by prefabricated modular constructive elements as prefabricated modules allow for improved quality, productivity, and predictable planning. As such the prefabricated market segment of the industry is expected to grow at 4.7% annually.[2]

Furthermore, new technologies and tools such as BIM *(Building Information Modeling)*, 3D Scanning along with cloud, desktop and mobile applications are changing the workflows of AEC professionals within the industry. Tools such as BIM help to digitalize the lifecycle of a project while allowing for a seamless collaborative environment to be formed between different stakeholders and disciplines. As such they lower the risk of the project as the information entered allows for better cost calculations and enables disciplines to check the model quality against project-specific requirements.[3]

Lastly new advancements in building materials such as self-healing concrete that uses calcite-precipitating bacteria in concrete to heal cracks in the concrete over time[4], eco-friendly insulating panels made from foam, sheep wool, plants etc[5]. and the introduction of the circular economy among others has led sustainability within the construction industry to become a key point of focus. As such sustainability within the construction industry along with the use of new technologies and building materials need to be implemented effectively. Construction costs are continuing to rise due to macro-economic factors such as inflation, lack of supply and higher labour costs. Especially as resources are scares and mismanagement can lead to higher costs and wastage of resources.

Figure 2: The global construction industry is responsible for nearly 38% of CO_2 emissions.

Hence to manage projects and resources more efficiently adoption of BIM within the lifecycle of a construction project is key. As such from 2011 to 2020 the adoption and implementation of BIM within the sectors of the industry grew from 13% to 73%.[6] This high adoption rate has led to a couple of challenges; as 59% of the companies either do not have the knowledge or skills to work with BIM, 36% of companies do not have proper procedures and protocols in place for BIM and 35.2% of companies lack the workforce to work with BIM.[2] As such many projects with BIM generate a lot of data. In the last three years project volumes have doubled in size.[2] However, this does not imply that all the data captured is useful. For if the data produced is not standardized between disciplines and supply vendors then it goes unused as it might not fulfil the project-specific requirements or meets the standard set within the BIM implementation & execution plans. As such currently 95% of data captured goes unused.[2]

This unused data can not only be considered useless data but can contain bad data. For if the BIM project doesn't contain a consistent naming convention, standardized parameters, and properties then there is a great risk of miscommunication occurring between the various disciplines and supply vendors. Additionally, the quality of the produced data from the BIM model needs to be identified, grouped and validated against BIM protocols, guidelines / frameworks, standards, information delivery manuals *(IDMs)* and project-specific requirements. As bad data can result in expensive reworks. Currently, 52% of all reworks globally originate from bad data and miscommunication resulting in a yearly avoidable loss of $31.3 billion. As such roughly 9% of a construction project budget goes towards unforeseen avoidable reworks. A 1% reduction in construction costs can lead to $100 billion saved globally.[2]

Figure 3: Yearly 52% of all reworks globally within the industry originate from bad data and miscommunication.

Standardizing of data can be achieved using BIM classification standards and IDMs. These are created either by local or international governmental and regulatory bodies that specify specific use cases for certain data structures in a BIM project. As such in the Netherlands, the BIM Loket has helped to define a couple of IDMs such as; NL-Sfb [7], BIM basis ILS [8], NAA.KT [9] etc. to help organize and standardize the naming of; file names, model entities, element hierarchy, classification, property values, spaces, and materials, among others. Internationally classification standards such as; UniClass, Uniformat, OmniClass etc. exist to help classify information within the BIM model for certain sectors of the industry.[10] As such data standardization removes unused data and reduces the chance for miscommunication between various parties, thus allowing for a better understanding, trust and collaboration between the various disciplines and supply vendors.

Validating the data quality of a BIM project can be achieved via several cloud *(BIM360 / ACC, etc.)* and desktop based *(Solibri, Navisworks, Revit etc.)* software solutions. Based on the project type along with how the data within the project is classified and standardized, two types of validations can be performed on the model. One is a visual & clash check against the project-specific requirements and the other is a check to validate the *(properties, value parameters, entity names, classification)* meta-data using rule-based conditional checking. Via the two types of checks, the information modelled within the BIM project can be assessed and bad data can either be removed or fixed. As such RFIs *(Request for Information)* or BCF *(BIM Collaboration Format)* issues can be created against areas of concern such that modellers can easily identify these areas and resolve them. By automating the data validation process, information within the BIM models or BIM project can easily be classified based on common property heading or values, validated against standards, rules & project-specific requirements and issue found can then be reported as BCF or RFI's to various stakeholders. Where BCF tools such as BimCollab and BimTrack can be used to manage issues.

With the use of BIM and data validation, current workflows can be improved. Where BFC or RFI issues can lead to newer versions of the BIM models, these can then be managed in Common Data Environments *(CDEs)* such as Autodesk Construction Cloud for a better Model Coordination between the various stakeholders, disciplines, and supply vendors. Once a new model version is published it can be retrieved, validated and issues once again rectified leading to the generation of a new BIM model. As such the process continues until the construction is complete and the building is ready for handing over. After the handing over the BIM project can be used as a digital twin for facility management and renovation.

In conclusion, data generated from various phases of a project if standardized and validated against project-specific requirements can not only reduce the risk of reworks required but can also improve the life cycle of the building. This is possible as information about the building and project will be accurate and readily available for current and future needs, thus reducing the wasteful usage of resources hence allowing for a sustainable project environment.

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