Digital Supply Chains in the Built Environment –
(DSCiBE) User Group

Digital Supply Chains

Data Driven Collaboration

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Foreword

By Espen Schulze

Digital strategy based on standards

The construction sector is ripe for change. Change is needed due to low margins, poor interoperability and sporadic technology adoption. The key to introducing digital supply chains in the construction sector lies in the implementation of technology based on standards.

Collaboration, standardisation (data structures, product identification) and open technologies are the means to enable supply chain actors to connect and exchange information seamlessly and achieve their organisational goals.

The ultimate goal of a digital supply chain in the AECO sector is to deliver value to the end-user through the seamless flow of standardised digital workflows.

This is why I am very pleased with the set up of the Digital Supply Chains in the Built Environment Work Group (referred to as DSCiBE) – an industry work group that offers expert guidance, knowledge sharing and best practice building for construction industry actors to support them in their transition towards digital supply chains.

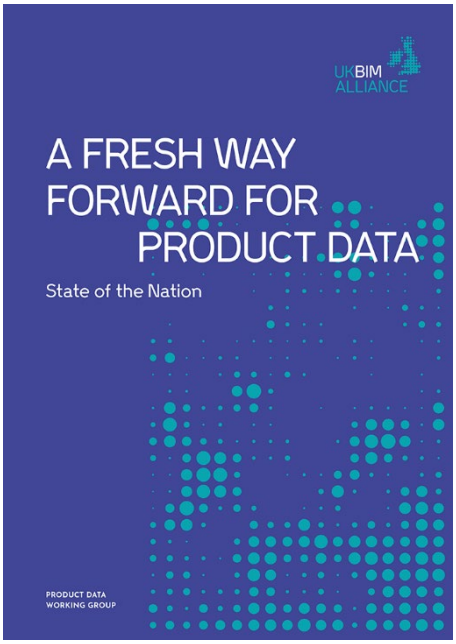
In this paper, I was happy to see a plain-language discussion of **the current set of standards** that industry leaders might consider in their efforts to set up or be part of the digital supply chain in the construction context. This is by no means an exhaustive list of standards, but it is a good starting point in opening the conversation about the standardisation landscape that is here to help the industry with its digital transformation today.

Executive Summary

This white paper explores how the use of common international standards can enable a digital flow of information within the entire supply chain employed on a construction project. How a common digital language between industry actors can drastically speed up a traditionally cumbersome and manual process leaving less room for errors in the building process, increased efficiency, reducing time and cost related to procurement.

To keep the scope relevant and backed by true example workflow, this paper provides evidence in the form of a real case study of the benefits incurred through the collaboration between a manufacturer and a contractor. The study paper touches on the likely benefits that are to be experienced by further supply chain actors, more particular exemplary use cases are to be provided in the next iterations of this work.

Introduction



With the setup of the Product Data Working Group, the UK BIM Alliance (now the UK Chapter of buildingSMART International) was among the first industry organisations to address the 'thorny and controversial' topic of product data by bringing different industry actors together. In an effort to shed light on the current 'state of the nation' through straight-forward and 'plain language' communication the Work Group produced a much-needed report named 'A fresh way forward for product data: State of the nation' [1]. It summarised some of the key issues with product data particularly from a UK client/contractor and a manufacturer perspective. At the **international level,** there has not been a similar effort to get industry engagement focused on topics such as 'product data' or 'digital supply chains'. The Digital Supply Chains in the Built Environment work group (DSCiBE) was born to fill this gap by bringing industry and experts together to tackle major challenges. The discussions focused on what standards are already available in the industry, the upcoming standards and the current developments in the field, when and where applicable. By preparing this whitepaper, the DSCiBE work group strives to produce a resource similar to the commendable effort by the UK BIM Alliance and will provide guidance and inspiration for any organisations who wish to join the open discussion around digital supply chains in the construction industry.

The DSCiBE workgroup and its value proposition

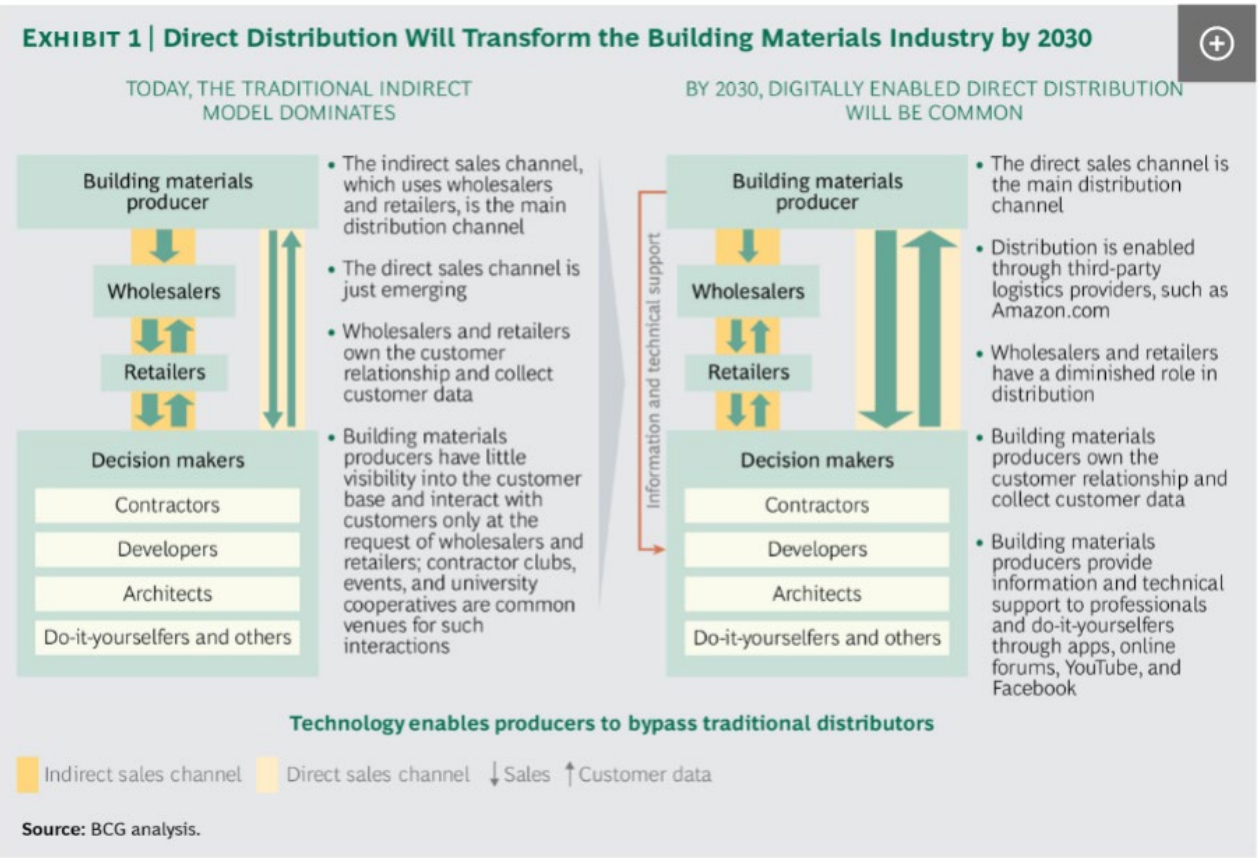
The Digital Supply Chains in Built Environment (DSCiBE) work group was launched in March 2019. This global initiative aims to bring together all major industry stakeholders which are involved in the Supply Chain of the Built Environment and to jointly develop processes for the digital exchange of all kinds of data, based on existing global standards. This digital data-driven collaboration will allow seamless collaboration between all parties in the Life Cycle Management of assets, from concept design all the way to facility management and eventually disposal. Its initial focus is on product/material master data, enabling a real-time "synchronisation" of the physical object with its digital twin during its existence, and even beyond (as data stays on longer than its physical twin). The initial beneficiaries of these efforts will be the manufacturers and contractors and from there the advantages will spread both up- and downstream in the value chain.

The efforts of the DSCiBE form an essential basis for successful BIM processes, as they bring the digital twin to life, allowing it to be synced in real-time with the physical object across the entire supply chain, irrespective of IT system, language, local regulation and/or classification system.

The DSCiBE is a workgroup open to all companies, associations and organisations that are interested to contribute in building a data-driven collaborative digital process based on existing global standards, be they Data Template standards, OpenBIM standards or Product Identification standards. In substance, it's all about linking the dots. Join us, engage with your pairs and start paving the truly digital way to true BIM implementation across the entire life cycle of assets.

A journey towards the digital supply chain

More and more construction industry actors see today's technology-enabled supply chains as means to unlocking high economic rewards. Among these rewards are the transition from a **product-centric to a customer value-centric** approach or 'servitisation' that leads to increased agility of all business functions and, revenue growth. The demand for digital services in the construction sector has been becoming a major driver for change and many building materials businesses have started looking at enabling their customers to purchase **building materials directly through the web and mobile apps, just as they do other products [2].** However, this is just part of the story.



Within a true digital supply chain, we establish a direct relationship with the end customer which brings along benefits such as longevity of relationships, engagement and co-creation. We know exactly what their requirements are and all that is left is 'how' to deliver them. The introduction of Building Information Modelling (BIM) is the first step towards a collaborative digital communication and has made the whole industry look at how it can deliver value through the use of data.

Clients, contractors, suppliers, consultants – all actors in the construction supply chain - have started to rethink their processes in light of the new information technologies available to them.

The industry's poor productivity record has been under the radar for many years, but it is only recently that the industry has started to address the issue through the application of digital technologies within the supply chain. So, why is now the time to work towards introducing digital supply chains in the sector?

The value of digital supply chains in other industries

McKinsey's report 'Strength in unity: The promise of global standards in healthcare' discusses how digital supply chains employed by the most progressive industries such as retail have already set out the steps to derive the most value from IT. How? By using standardised information management processes to streamline the relationships between devices, products, locations and customers, and by using shared information resources, information modelling, smart analytics and by adopting

automation. In short – the industries with the highest maturity of their digital supply chains have utilised standardisation of information management at a global scale [3].

Information Management – the hardest bit

Much like the healthcare industry, construction is multifaceted, heterogeneous and heavily regulated both at the local and the international level [4]. This makes information management in the industry an inherently bureaucratic process. Here is where standards provide the industry with the needed guidance. Often seen as ‘too complex’ for the everyday work context, CEN or ISO documents provide the clear, yet flexible framework for the establishment of strong information management [5]. The definition of uniform, consistent and repeatable processes that would allow for access to accurate and trustworthy data across the industry is only possible when the actors responsible for this data participate in the process of mutual agreement which is standardisation.

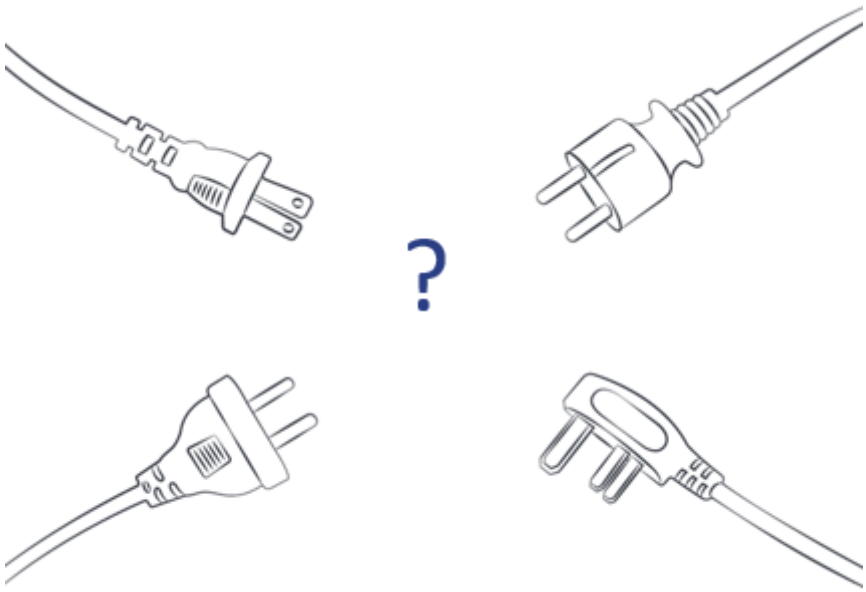


Illustration: A world without standards!? Cobuilder AS @ 1997-2019

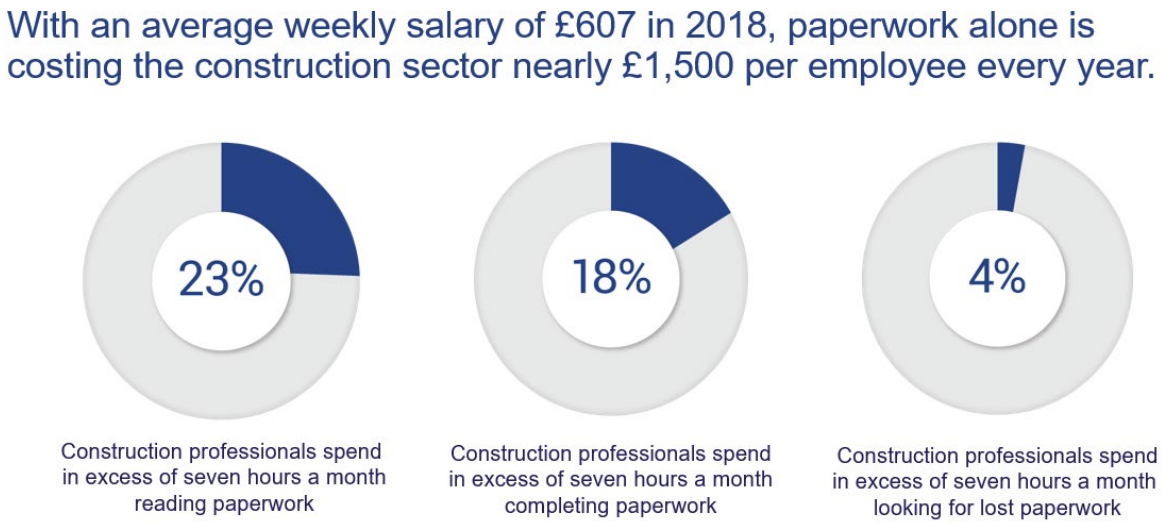
In that sense, and back to the question of ‘Why now?’, the AECO sector has made the most important step towards digital supply chains - global standardisation efforts have reached critical mass.

Current Industry Challenges

Any commercial built asset or infrastructure involves millions of products, numerous hours of labour, complex logistics and a large technological landscape. However, the main driver of complexity related

to construction are the sheer numbers and influence of stakeholders responsible for the different domains of design, construction and operation. All these stakeholders form a complex supply chain that generates huge amounts of knowledge and data, which regrettably gets ‘lost in translation’ or lost altogether.

The inefficient knowledge transfer that still relies mainly on paper to manage processes and deliverables such as blueprints, design drawings, procurement and supply-chain orders, equipment logs, daily progress reports, etc. is stripping the whole sector of the opportunity to analyse and exponentially learn from previous experience and mistakes [6].



Source: Office of National Statistics (ONS) UK 2018

Globally, labour-productivity growth in construction has averaged only 1 percent a year over the past two decades, compared with growth of 2.8 percent for the total world economy and 3.6 percent in the case of manufacturing [7]. A huge performance gap fuels this lack of productivity as construction firms have historically charged low initial fees and made up their margins with changed orders and compromised quality. Terrible accidents such as the Grenfell Tower fire[1] in 2017 have shown us that this contentious relationship with the end-user and society in general is still very relevant today. Bringing about a better, more sustainable and safer built environment seems to be part of each construction organisation’s objectives, but the lack of a ‘golden thread’ of information on most projects in practice is striking. This is why, Dame Judith Hackitt DBE FREng recommends that a BIM-enabled

[1] On 14 June 2017, a fire broke out in the 24-storey Grenfell Tower block of flats in North Kensington, West London. It caused 72 deaths, more than 70 others were injured and 223 people escaped. The fire was started by a malfunctioning fridge-freezer on the fourth floor and spread rapidly up the building's exterior, bringing fire and smoke to all the residential floors. The rapid spread has been attributed to the building's cladding, which is a type in widespread use, along with the external insulation. In the aftermath of the fire, the national government commissioned an independent review of building regulations and fire safety, which published a report in May 2018. Across the UK and in some other countries, local governments have investigated other tower blocks to find others that have similar cladding. Efforts to replace the cladding on these buildings are ongoing.

supply chain that keeps and maintains a digital record across the building life cycle is a crucial prerequisite in building a safer future [8].

However, even where digitisation occurs, due to the lack of standardisation, information sharing is delayed and inconsistent. **Manufacturers, owners and contractors** often work with different versions of reality in their own information silos which makes it difficult and almost impossible to capture and analyse data. This has a huge impact on the industry because BIM is a collaborative process and even when the flow of digital data is secured, the true benefits of data management are only experienced when fit-for-purpose data is exchanged and used by all the actors across the supply chain.

Up to 90% of the project turnover of main contractors is spent on buying goods and services [9]. The management and, at a later stage, the delivery of invalid or unchecked data by the main contractor and their supply chain can lead to problems. If data is incomplete or lacking the required detail at the late phases of the project, changes become expensive and difficult to control, not to mention the risks associated with regulatory compliance.

The **construction industry has undergone major changes** caused by the introduction of new laws and regulations related to global trade, product innovations, technology and improved processes. These changes have affected construction products and component manufacturers as well. Today, actors are in the unique position to **use data as means to create a** powerful change themselves – a change that will bring benefits not only to their business but also to our society as a whole.

Today, major market and political struggles in Europe take place between wholesalers, producers and other players. Issues such as who should ‘own’ what data often arise. Data becomes a power factor with a strategic value. Here manufacturers have a unique opportunity to establish themselves as key players.

The construction industry will increasingly rely on consistent product (systems and components) data. Therefore, it is crucial that individual manufacturers take responsibility for their own data to ensure long-term benefits.

Within the manufacturer’s IT environment, internal systems are used for meeting economic needs (ERP), customer support needs (CRM), marketing needs (PIM, WEB) etc. Yet, most important product data is shared with clients via unstructured digital formats (word, pfd, xls) or, in some cases, third-party providers (product databases, object libraries). For the supply chain users of these product data, this can lead to many inconsistencies, plain errors, data loss, versioning problems and general poor quality of the data.

For the manufacturers, this means managing numerous database duplicates, incurring huge operational inefficiencies and missed economic opportunities. Such implications exemplify the need for setting up a digital strategy that looks at both internal and external data and the connection between the two in order to create a consistent data architecture optimised for both internal and external users.

This is why, while essentially there are many types of information that can benefit from digitisation and standardisation – data about the products installed in a built asset seems the most relevant for the establishment of the digital supply chain in the industry.

In the following section we will introduce you to some of the current standardisation work looking at data management in the construction industry today.

Structured Data and Product Data Standards

Currently, approaches to managing digital information are already established and widely applied in many organisations. This has created adverse implications for the industry as no single standard approach is applied to make the flow of information universally sustained so that all actors, regardless of their particular context, can leverage the benefits of digitisation. As the UK BIM Alliance report points out – currently there is no universally agreed definition of what structured data is and no commonly agreed data standard(s) in the UK or in Europe for digital product data.

To address this issue, European and International standardisation bodies (CEN, ISO) have set up technical committees solely responsible for the development of a structured set of standards that specify methodologies to define, describe, exchange, monitor, record and securely handle all data used within the construction sector. Furthermore, International industry organisations such as buildingSMART International (bSI), European Construction Industry Federation (FIEC), Construction Product Europe (CPE) etc. are involved with this standardisation work. This creates a community of international stakeholders who bring expertise to the process and help for the co-creation and implementation of standards across the global construction industry.

Within the European standardisation body CEN, The Technical Committee TC/442 was set up to take charge of the standardisation work regarding all information in the built environment.

The work programme of the TC/442 committee includes - according to the Vienna agreement and where appropriate - to make current ISO standards for BIM valid as EN standards. That is why, the work is carried out in close cooperation with the ongoing BIM standardisation by ISO committees such as ISO TC/59.

Among the first standards adopted by the European standardisation body CEN, under the careful work of TC/442 were the three openBIM standards. In October 2016 the buildingSMART International standards: IFD (ISO 12006-3:2007), IFC (ISO 16739:2013) and IDM (ISO 29481-2:2012) were officially adopted as EN standards as part of the BIM standardisation agenda of CEN/TC 442.

These standards are widely known as the **three pillars of interoperability**. They set out a common format for data exchange, a common structure for defining data-semantic concepts and the relations between them into a data dictionary and a standard to specify how to describe the required information supporting a given process.

Moreover, these standards provide the opportunity for freedom of choice of BIM authoring tool. This ensures industry actors can choose their preferred tool or application. This enhanced level of interoperability has driven significant value for all industry actors. These three standards have provided a foundational layer and platform to deliver flexibility and choice for the industry. These have been critical in ensuring further working groups can build on these open formats as a non-proprietary initiative.

Then comes the second level of standards that are currently developed by CEN TC/442 and are to be published in early 2020.

prEN ISO 23386 (WI=00442007): Building information modelling and other digital processes used in Construction – Methodology to describe, author and maintain properties in interconnected dictionaries

It provides a methodology to define and manage construction object characteristics for digital use. The principle is to connect every characteristic (called ‘property’ in the digital world) to attributes such as the definition derived from a reference standard within a particular local context. The process creates a rigorous system of validation of all digital contents and defines how ‘properties’ and ‘property groups’ shall be established by experts in a data dictionary, as well as how this content shall be mapped to other data dictionaries. The objective is to allow quality information exchange between industry players for multiple uses such as the digital model, also for international trade, and the needs for maintenance.

prEN ISO 23387 (WI=00442010): Data templates for construction objects used during the inception, brief, design, production, operation and demolition of facilities

Part 1: Concepts defining the general structure of data templates

Sets out the general structure that can be used to digitally describe any construction object within the construction works and building services. This structure is called a Data Template and should be based on concepts and the relationships between concepts sourced from a data dictionary. A Data Template is a collection of standard-based properties collected in groups of properties, which can be traced to credible sources such as, for example, harmonised standards under the Construction Products Regulation (CPR), and any other European standards defining construction object characteristics.

CEN/TC 442/WG 4 (WI=00442008): Framework for data templates under CPR

Describes how Data Templates should be specifically created based on harmonised standards and European Assessment Documents (EAD), using the common European technical language already existing in the harmonised technical specifications, and in normative references. This common technical language should be the foundation when creating a digital terminology for the European construction industry. In this way the Data template will become the link between harmonised standards and an open European data dictionary, which will allow for manufacturers to supply their data for digital use.

Important as these standards are, however, it would be an understatement to say that there is some confusion regarding how construction industry actors should use them. This is partly due to the fact that 'BIM community' terms like 'construction object', 'data template', 'property' or 'data-semantic concepts' are still very obscure to the general public and the initiatives to use 'plain language' when describing everything BIM, are still in their earliest stages.

In the next section, in an attempt to put these standards in context, we will be looking at how these standards solve some of the challenges that are relevant to industry actors today.

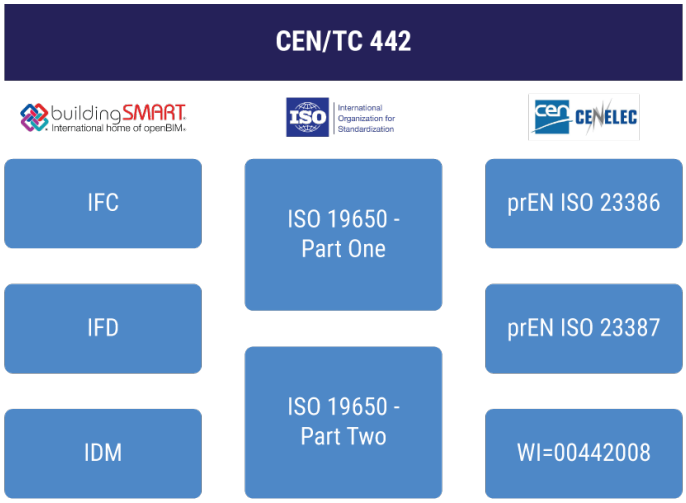


Illustration: The standards under CEN/TC 442 you should know about. Cobuilder AS @ 1997-2019

Challenge #1: Defining what Structured Product Data is

What a 'product' is, is the most difficult question related to the management of data. Products themselves are described by different properties and these properties have their own attributes. There is data about the transactions related to products, such as stock data, financial data, data that relates to the fabrication process etc. Defining what product data is can be as diverse as the nature of the businesses who manage data.

However, the needs related to product data are very similar. Product data needs to be consistent when shared between different applications and to conform to rules set by standards and regulations related to the manufacturing of products. It needs to be machine-readable and versatile so it can be classified and translated without losing its meaning. It needs to be structured. The UK BIM Alliance report 'A fresh way forward for product data: State of the nation' defines structured data as:

Structured data is data that has been defined and organised in such a manner that it is immediately identifiable, and machine-readable within an electronic file.

Structured data must be:

- Defined in a standard way, i.e. identified by naming conventions
- Presented in a standardised format, and
- Transferrable and translatable between users of the data and their software choices, i.e. interoperable

The word ‘product’ can also be problematic within this definition. In the context of this whitepaper ‘product’ equates to a ‘construction object’, which can be defined as object of interest in the context of construction process (ISO 12006-2:2015). Therefore, ‘a construction object’ can be used to denominate e.g. product, system, assembly, space, building etc, however we have chosen to use the term ‘product’ to avoid the confusion with 3D CAD objects.

When talking about structured data, one question immediately surfaces:

Can Excel manage product properties?

A product property is not the smallest building block defining a product for digital use. It contains attributes such as commonly agreed naming and definition, translations and connections to other concept types such as ‘unit’, ‘value’ etc., constraints on data type and format, versioning history and more.

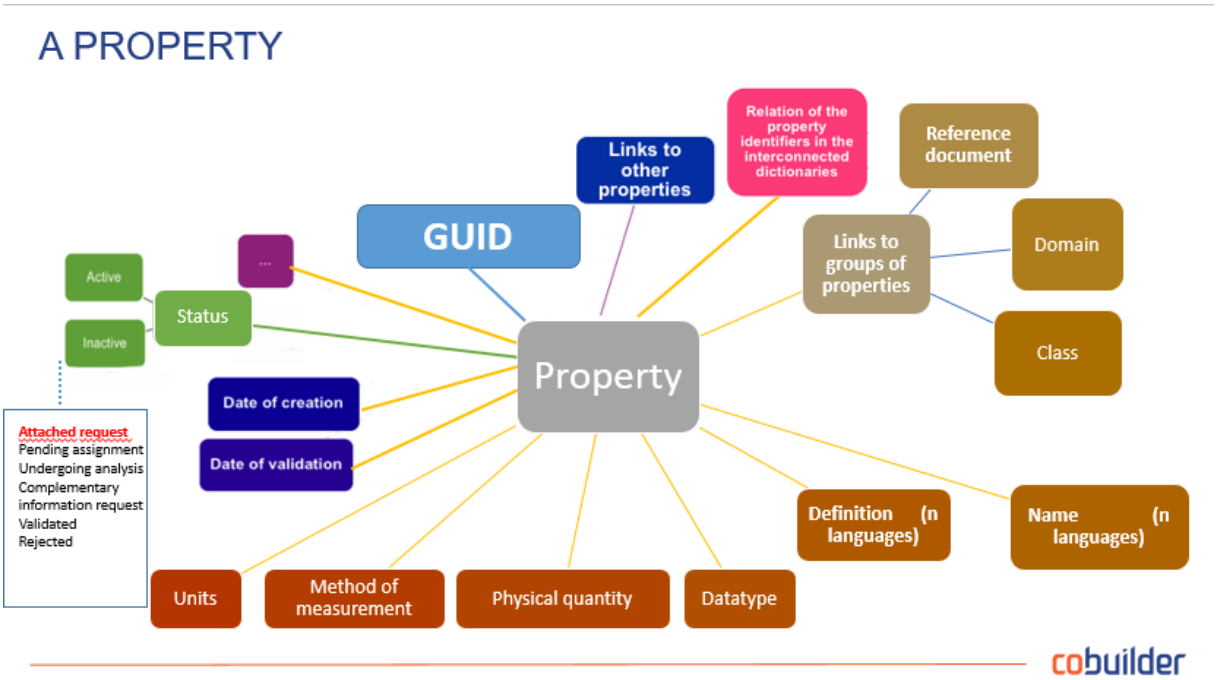


Illustration: The Anatomy of a property. Cobuilder AS @ 1997-2019

When creating a spreadsheet in Excel with a list of product properties there is no way to create the web of links and attributes that define one. An Excel structure is static, it cannot guarantee the capabilities to export/import into different formats, as it is in no way structured - any field can contain any piece of information, which hinders machine-readability.

Using Excel, anyone can edit and change the data fields containing product characteristics as they wish – i.e. it is not possible to enforce data governance and maintain clear information management process. This means that the format may become full of repetitions and unnecessary data fields over time, not to mention inconsistencies and mistakes.

Data Governance is a major point of concern in the predecessor of prEN ISO 23387 – the French standard **PPBIM** (*XP P07-150*). The process described in both of those standards creates a rigorous system of validation of all digital contents and defines how properties and property groups shall be established by users and domain experts in a data dictionary, as well as how this content shall be mapped to other data dictionaries. The objective is to allow quality information exchange between industry players by bringing in field expertise and a process where expert with domain expertise approve or reject changes in the templates in order to maintain consistency and manage duplicates.

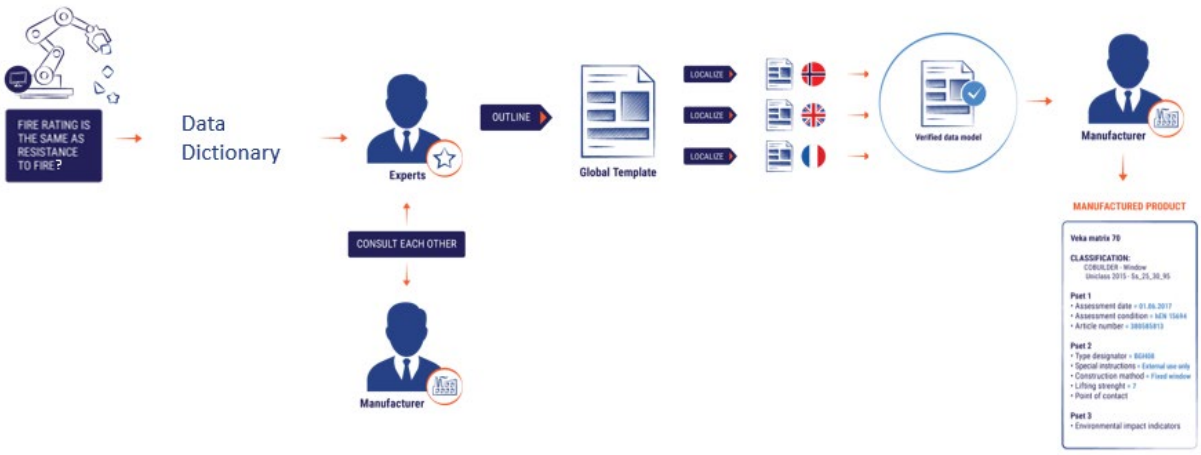


Illustration: Data Governance within Data Template creation, localisation and use. Cobuilder AS @ 1997-2019

Solution to challenge #1: Standard-based Data Structures

As per the standards **prEN ISO 23386 & prEN ISO 23387 (WI=00442010)**, a Data Template is a common data structure containing the ‘properties’ (construction object characteristics e.g. fire rating and colour), ‘measures’, ’units’, ’values’ stored in a data dictionary. Data Templates describe any type of object for construction works and building services in a way that can be traced to a credible source. Such credible sources are standards declaring the performance characteristics of construction objects

and the methods they should be tested against.

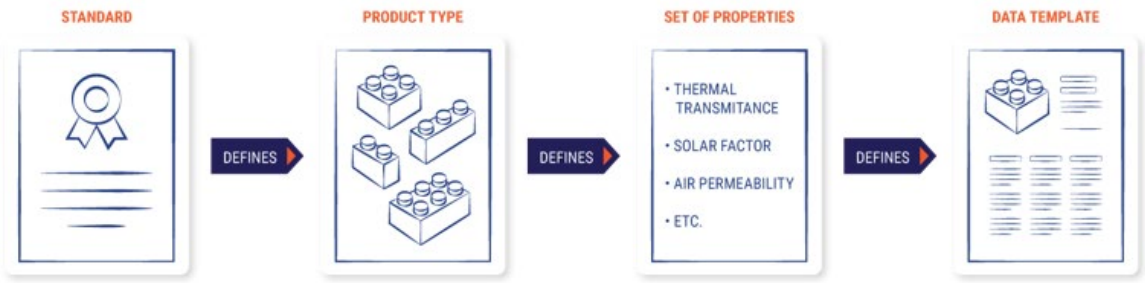


Illustration: From standard to Data Template. Cobuilder AS @ 1997-2019

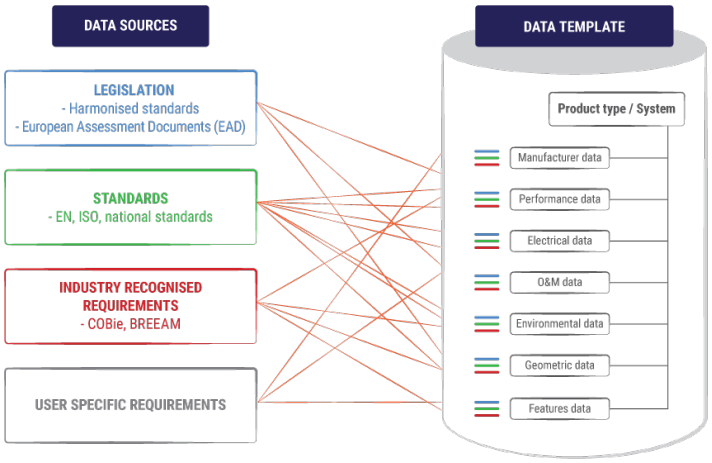


Illustration: The Data Template. Cobuilder AS @ 1997-2019

In order to make a Data Template applicable to different international contexts there is a specific hierarchy of credible data sources considered in the Data Template structure. Legal data sources such as European Harmonised standards (under the Construction Products Regulation) and other non – harmonised European standards are with greater priority than national standards that have greater priority than industry and user recognised requirements (like BREEAM, COBie). This is how Data Templates are created to serve as a common framework for anyone to use internationally in order to manage construction object related data in a systematic way.

Data Templates can be used for structuring data needed to complete tasks at different construction stages. Any actor involved in a construction project can use them to set data requirements, populate them with actual data and verify input data against requirements. With regard to the Smart CE Marking initiative by Construction product Europe, Data Templates **are especially useful for manufacturers**

who can populate them automatically with the most up-to-date and accurate information about their products and produce legally required documents such as The Declaration of Performance, needed for affixing the CE Mark.

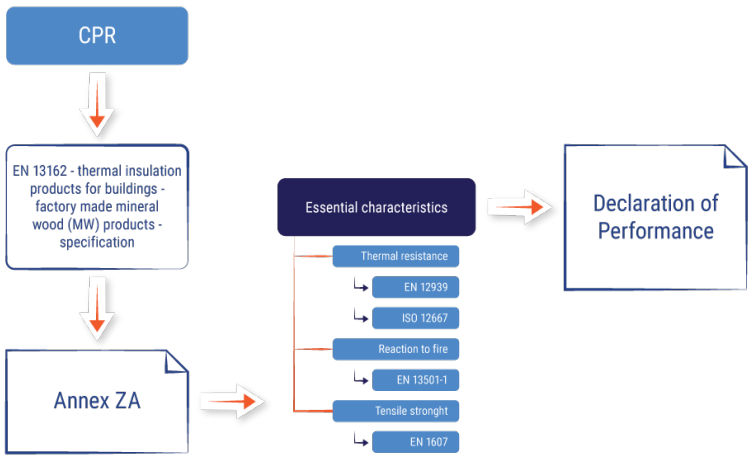


Illustration: Where does the content of a data template come from? Cobuilder AS @ 1997-2019

Because the Data Template methodology is developed in conjunction with the IFD standard and credible sources such as the CPR within their logic, they provide the link between real and the digital world and make sure that construction object data is truly interoperable.

How are Data Templates related to the IFD standard?

How is a simple concept used within the construction industry to denote an object such as a ‘door’? The term ‘door’ in some countries, for example Norway, means the ‘door leaf’ together with the ‘door frame’, and in other such as the UK, it only means the ‘door leaf’. A ‘door leaf’ together with a ‘door frame’ in the UK is known as a ‘door set’. In many similar cases, the terminology used for similar concepts such as a ‘door’ can differ (e.g. door and ‘door set’ meaning the same thing) or the same terminology can be used to denote different concepts (e.g. ‘door’ is a door leaf in the UK and it is a leaf and frame in Norway).

While people can easily sort out such issues by referencing a standard that defines what a door is, computers definitely cannot do it on their own. That is why in order to help machines understand the intended meaning of information there is a need for a common semantic framework of concepts, grouping of concepts, and the relationships between concepts to be used.

The International Framework for Dictionaries (IFD – EN ISO 12006-3) sets the rules for building a language independent information model that allows all sorts of systems to take advantage of concepts that can be referenced from within a common framework.

The Global Unique Identifier (GUID) is the most essential element in this common framework. It serves as a unique, language-independent identifier of each concept and each relationship between concepts. This allows for a common understanding of terminology as it is always for equivalent concepts to be connected to the same meaning no matter the different context (national standard, national languages, languages used within different software) and similar terms that denote different meaning to be connected to their specific meaning.

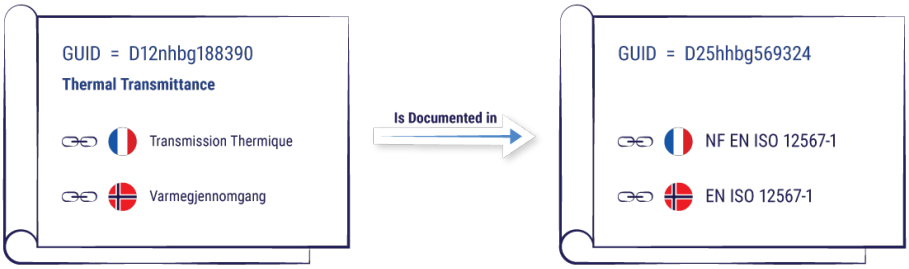


Illustration: Linking concepts within a data dictionary framework. Cobuilder AS @ 1997-2019

In practical terms, a data dictionary is a connection box, that contains all the technical terms actors need, mapped towards translations and other related concepts so that when one gets something out of the box it contains a unique ID that keeps all the relevant connections and meanings attached regardless of the language you export it to.

GUIDs allow for a concept such as a ‘door’ within a data dictionary to be logically related to GUIDs of other concepts such as property, measures, units etc. Using all this GUIDs and relationships, the subject ‘door’ is related to its property ‘fire rating’. The ‘fire rating’ has a specific assessment method - measure, which is then expressed by a specific value with a specific unit.

This is how construction object data sets are created in a data dictionary. Ideally, a data dictionary would hold the complete diversity of concepts and relations between them. As it is a dictionary, however, it does not single out all the concepts and relations that are specific to any singular type of product. This is why, the content that has been credibly sourced from EU and International standards and has been properly stored and defined for digital use in a data dictionary has to be organised into data structures called Data Templates.

In summary Data Templates based on standards present data in a standardised format, identified by naming conventions, while the data is transferrable and translatable between users of the data and

their software choices, i.e. interoperable. This ticks all boxes and makes Data Template the solution to standardised data exchange within the sector.

Challenge #2: Data Exchange of Structured Data

IFC: dispelling some confusion about interoperability

buildingSMART's Industry Foundation Classes (IFC) specification is a neutral, non-proprietary data format used to describe, exchange and share information. IFC was developed to facilitate interoperability, but it does not itself guarantee interoperability. While all sorts of data can be transported through IFC, the sheer flexibility of the format allows for multiple ways to represent the same product information. Without a unified approach this can lead to different implementers addressing same object in with incompatible representations, complicating verification and validation of set requirements. IFC is an exchange format – therefore it should not be used to organise, qualify or structure data.

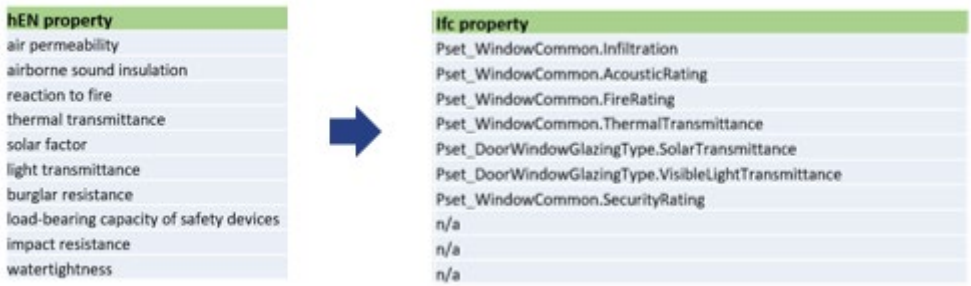
Construction products, mechanical, electrical and plumbing (MEP) systems and assets are subject to different technical, legal and market requirements and as such are described by very different properties (these can be based on the location, purpose or intricacy of the project). Which of these properties should become part of the data exchange, who is responsible for the values attributed to them, how do we agree at all on their meaning? Once we agree on the open exchange format for the construction industry, those questions and many more like them will immediately become very relevant very fast.

Luckily, both within buildingSMART and CEN/TC 442 experts think ahead of the game and have started to lay down the foundations for what goes inside a data exchange. The ongoing standardisation of the Data Template concept will allow actors all around the world to compile sets of mutually agreed properties for product and assets and use them to express specific data requirements on projects.

The current state of affairs

Some may argue that IFC already has built-in properties for various assets. This statement is right, however, there is a complexity to be considered here. The various building element representations in IFC2x4 are accompanied by properties like Fire Rating, Acoustic Rating and Thermal Transmittance, among others, but often these fail to reflect the precise terminology of a particular locale. Windows in the US do not have an Acoustic Rating, they have Sound Transmission loss classes. Wallcoverings in Europe do not have a Fire Rating property, they have a Reaction to fire and a Resistance to fire – two

inherently different parameters. This poses an issue when the values of the localised properties need to be attributed.



hEN property
air permeability
airborne sound insulation
reaction to fire
thermal transmittance
solar factor
light transmittance
burglar resistance
load-bearing capacity of safety devices
impact resistance
watertightness

Ifc property
Pset_WindowCommon.Infiltration
Pset_WindowCommon.AcousticRating
Pset_WindowCommon.FireRating
Pset_WindowCommon.ThermalTransmittance
Pset_DoorWindowGlazingType.SolarTransmittance
Pset_DoorWindowGlazingType.VisibleLightTransmittance
Pset_WindowCommon.SecurityRating
n/a
n/a
n/a

Illustration: Standardised properties vs. IFC Properties. Cobuilder AS @ 1997-2019

Moreover, the built-in properties in IFC today are not a good fit to communicate the methods of measurement, test procedures and calculation methods to be applied for the determination of the property values. Such information is essential, as it is the basis on which specifications are made and real-world products are evaluated. Different test methods result in different property values, with specific boundaries and measurement units, which the built-in IFC properties do not represent currently. So, what can be done?

Both the terminology and the particular test, measurement and calculation methods are found in standards. Every region around the world relies on product standards and testing standards to describe products and prove they are safe and useable. This is especially the case for the construction industry – these standards are deeply engrained in the design, manufacturing and procurement process, and form the actual information actors exchange regarding construction and MEP products. They are the most credible source for product properties. So, what does this mean for IFC?

It can be argued that IFC is a flexible format that allows users to create custom properties, so this can be one solution to the current issue. This is correct, but what is missing here is a standardised, uniform way to do this. Without a uniform way of approaching the properties used in IFC, two software tools generating IFC may model the same property coming from the same standard in two completely incompatible ways, failing to efficiently exchange information without additional adjustments and losses.

These comments apply to native formats used in proprietary modelling software such as Autodesk Revit, ARCHICAD, etc. too. Most proprietary model formats come with some built-in properties that are meant to be as flexible as possible but end up throwing in more confusion, than helping.

Challenge #3: Identifying a product

BIM tools and designers/specifiers are good at setting down their project requirements and manufacturers have the knowledge to fulfil these requirements, but even when the match requirements vs product is successful, how is this information recorded? How do we know that this product has been purchased specifically to fulfil this requirement? After it is installed how do we know that the proper product has been installed to the proper requirement? How can we know what's inside an existing building in a refurbishment project?

Products need to be uniquely identified to be traceable both when supplying the construction site and when creating the as-built model. It is obvious that this has to be done but it is not set out how exactly. Even in cases where manufacturers and contractors work closely and can uniquely identify and track products, this solution is still closed and discrete – it works only between those two actors. Standards are needed that not just identify products but also do it open and uniformly that ties in with the rest of the world.

A suggested solution to data Identification

In order to enable the creation of digital supply chains within the sector, we must make sure that products can be clearly identified by anyone (or any machine) at any part of the product's life cycle and at any point in the supply chain. To create trust within this process of identifying the one single source of the data is, of course, the manufacturer. Once the link between the manufacturer and his chosen identification system is established, the identifier must persist in time, making the solution to identification issues fit for the long years of operation that are characteristic of the construction sector.

There is no need to reinvent the wheel here. The international not-for-profit organisation GS1 has decades of experience in the digital identification of products. For years they have come up with a surprisingly simple approach of managing data throughout a product's life cycle, that consist of four basic keywords – Identify, Capture, Share and Use. Behind each of these are a number of standards and services ensuring a seamless information flow.

Identify – This is the first step in digitising the supply chain. Each participating element – products, locations, assets - must be distinguishably identified. To this end, GS1 has come up with a number of standardised numerical identifiers, some of the most relevant being:

ID Key	Used to Identify	Example
Global Trade Item Number (GTIN)	Products and services	Can of soup, chocolate bar, music album
Global Location Number (GLN)	Parties and locations	Companies, warehouses, factories, stores
Serial Shipping Container Code (SSCC)	Logistics units	Unit loads on pallets, roll cages, parcels
Global Returnable Asset Identifier (GRAI)	Returnable assets	Pallet cases, crates, totes
Global Individual Asset Identifier (GIAI)	Assets	Medical, manufacturing, transport and IT equipment
Global Service Relation Number (GSRN)	Service provider and recipient relationships	Loyalty scheme members, doctors at a hospital, library members
Global Document Type Identifier (GDTI)	Documents	Tax demands, shipment forms, driving licences
Global Identification Number for Consignment (GINC)	Consignments	Logistics units transported together in an ocean container
Global Shipment Identification Number (GSIN)	Shipments	Logistics units delivered to a customer together

ID Key	Used to Identify	Example
Global Coupon Number (GCN)	Coupons	Digital coupons
Component/Part Identifier (CPID)	Components and parts	Automobile parts
Global Model Number (GMN)	product model	Medical devices

Capture – Once assigned, these identifiers have to be physically represented in the real world, to enable tracking and recognition. GS1 supports several standards for tagging (by direct marking) actual physical items including the widely known barcodes (both linear and 2-dimensional, such as DataMatrix and QR-code), but also RFID (Radio Frequency Identification) tags that store the encoded identifiers and allow for scanning from a distance. This allows users quickly and correctly to recognise a product or asset arriving on site.

Share –This layer represents how the different identifiers actively interact across the supply chain and are all about interoperability. The “Share” standards describe how to find and verify a product, how to exchange information regarding orders, deliveries and payments, how users can share information about the movement and status of products as they travel from business to business, and how to record other significant events that occur during a product’s journey from cradle to grave. The standards achieve business interoperability by setting out a unified system of messaging for the various transactions and events during a product’s life cycle.

Use – Identified, Captured and Shared information is put to use in streamlining business processes. A product with a GS1 GTIN (Global Trade Item Number) can be tracked at any point of its journey, information about it can be quickly accessed and verified by end-users (consumers, patients, maintenance workshops, etc..). The assignment of a GS1 identifier to an actual physical product essentially creates a digital twin, where the identifier is attributed all information inherent to the physical item. This unique relationship between real and virtual is also seen as an IoT enabler.

These concepts have been well established in the Retail, Foodservice and Healthcare industries, greatly improving the access to product data for all participants in those sectors. First steps of

adoption of these globally GS1 standards have been made in the Automotive, Engineering and Railway industries. This has allowed manufacturers, suppliers and distributors in all of these sectors to optimise their business processes by tracking stocks, availability and demand. It has allowed consumers to find product data quickly and accurately, increasing satisfaction and brand trust. These factors, together with the machine readability of GS1's approach has driven e-commerce to unprecedented scales in recent years. Customers can easily look up a product, make an informed decision, purchase from the other end of the world, and know when exactly to expect delivery.

The construction industry has yet to tap into this potential. Transparency, information management and longevity, and supply-chain management are seen as some of the major challenges faced by the sector that digitalisation can resolve. While the new standards by CEN/TC 442 address how asset information should be managed (EN ISO 19650 series) and how construction product data should be captured (EN ISO 23386 and EN ISO 23387), it is still unclear how information should be exchanged practically, especially during the procurement and construction stages when the virtual design is translated into a real building. And the access to the true source of product data – the manufacturers – is still unresolved. This is where GS1's rich experience must come in - globally unique identifier standards like GTIN (for products), sGTIN (instances of products), GRAI and GIAI (assets), and GLN (plants, sites and warehouses) can readily be used to identify, track and synchronise information during procurement, on site during assembly and during operation and maintenance. The unique identification together with the structured product characteristics derived from data templates according to EN ISO 23387 can provide the needed level of information richness necessary to sustain the 'golden thread' about construction products, directly contributing to the information exchange and management processes set out by EN ISO 19650.

Current progress and next steps

Summary of the use of data templates in the industry

We are yet to see the major disruptors in the construction business, the new 'Uber' and the construction industry 'Amazon'. Forward-thinking manufacturers and contractors have realised the emergence of new digital supply chains and the first success factor they have turned to is the proper management of their data assets through a consistent data strategy.

The forward-thinking manufacturer

Highly conscious of the importance of the 'I' in BIM, forward-thinking manufacturers such as Wienerberger AG, BMI, NorDan, Knauf Insulation have done a tremendous effort internally to bring value to their customers by increasing the quality of their product-related data services. Along the organisational digitisation journeys, however, data experts have been faced with numerous challenges

concerning the consistency and standardisation of data management practices of product (systems, materials etc.) data across the whole group and its brands. Finding a holistic solution to enterprise data management was identified as an issue with strategic importance for pursuing the objectives of each of these global businesses.

> **'Wienerberger AG were among the first manufacturers to identify and clearly state that they needed a common, agreed, international, translatable, interoperable, data model that can be applied across the organisation's vast portfolio. When we started our common project, they had already realised that the answer of this need lays within the application of the construction data management standards currently being put forward by CEN within the Technical Committee 442 (expected to be published early 2020) and ISO TC/59. Our shared vision of the importance of the ongoing standardisation work created a firm partnership between our teams. This allowed Cobuilder to gain a deep understanding of Wienerberger AG's specific organisational challenges and co-create not only a solution but also a robust data strategy that can be gradually adopted across the whole group.' – says Lars Chr. Fredenlund, CEO of Cobuilder AS.**

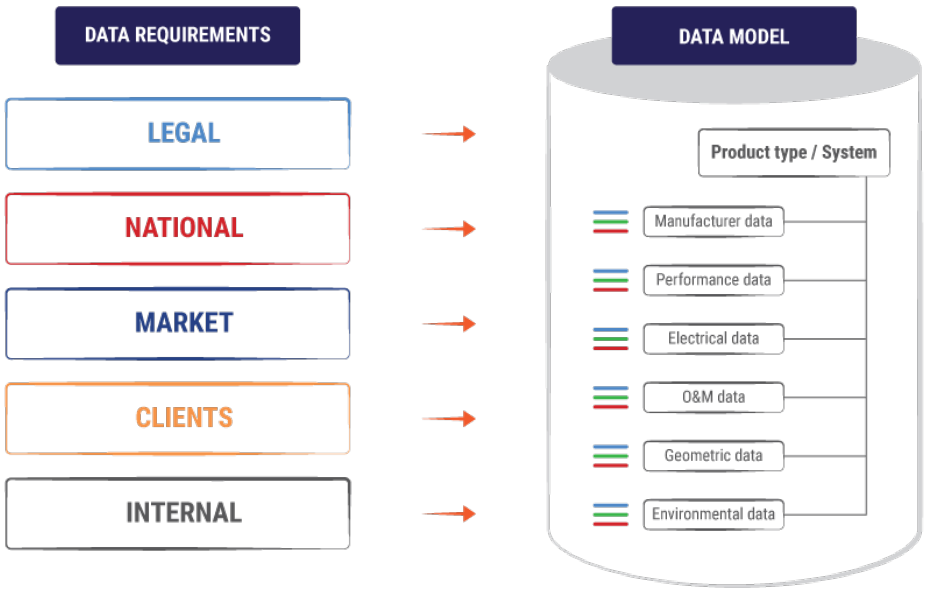


Illustration: A Data Template can be used to set an enterprise level data model. Cobuilder AS @ 1997-2019

After introducing their standards-based data strategy Wienerberger reported a 20% reduction in properties managed by the organisation. This was a direct result of the mapping and data de-duplication brought about by Data Templates as a solution.

Today, Wienerberger AG uses a cloud-based DT system that allows for interoperability and automation. When a change is made in the PIM systems it is fed to this system, and through it, data is translated to any third-party system.

For instance, when the data about a specific product that is changed in the PIM system is automatically reflected in Revit through a plugin that sources standard-based data from goBIM in a format especially ‘translated’ for Revit.

The implementation of such a holistic enterprise solution has opened up numerous opportunities for Wienerberger. Their product data are now freely available to various actors in the construction industry, allowing all clients (in all market channels) to query product properties and product digital assets and subsequently have the data mapped and structured to all digital formats and software such as IFC, Revit, Nemetschek, E-TIM–RT, B@uClass and ArchiCAD.

The forward-thinking client/contractor

Every organisation commissioning a built asset does this to fulfil different strategic business goals. It is important to say that these business goals relate to different stakeholder groups including the end users of the asset and society as a whole. These goals can be translated into various information requirements that have to do with anything from efficiency in asset management and compliance to different regulatory duties to portfolio value planning and many more.

Since the autumn of 2018, Statsbygg - the Norwegian government's key advisor in construction and property affairs, property manager, and property developer, have set a paperless BIM process as a firm requirement on all their projects. To meet this demand the biggest contractor on Norwegian public projects - NCC Building Nordics has started several research and implementation projects to achieve digital paperless workflows in all stages of a construction project.

Through their research, NCC learned that their construction projects and the related activities of design, procurement, construction, manufacturing and operation, generate huge amounts of data about the building elements used. Unfortunately, this data is often unstructured, not standardised and consistent and gets ‘lost in translation’, thus stripping the contractor of the opportunity to analyse and learn from previous experience and mistakes. Consequently, making it difficult for the different actors involved meeting their employer’s requirements, to operate effectively, to manage costs, and ultimately, to create a better-built environment.

To get better control of their data and to ensure an effective flow of this data between various systems, NCC **set out to** develop standard-based Data Templates (DTs) for a variety of building elements. OpenBIM standards were used to facilitate seamless digital communication between all involved. Through using data templates to provide the structure and language for digital data exchanges

between the different actors, NCC was able to maintain the ‘golden thread’ of information and draw benefits from the way this data is handled throughout the process of procurement.

Through the implementation of Data Templates, NCC was able to demonstrate a workflow that was truly innovative in the history of digital construction.

Based on NCC’s data requirements, captured within the agreed templates, architects were able to detail the model and specify a construction element (window). This was then exported as an IFC file and sent to a manufacturer of windows. The manufacturer took the role of a consultant who proposed the right products for the respective project. The manufacturer provided data back as a proposal, which was converted to an IFC file and first stored within the common database CEDB, and later upon approval integrated into the architectural model. This was only possible because all involved (contractors, manufacturers, architects) were working with the same technological language (through the use of the bSDD), same data structures (data template) and the same exchange format (IFC).

Both NCC and the window manufacturer kept catalogues with predefined elements, which were previously used as a start for the information exchange with their clients and suppliers, respectively. However, once they were working with the Data Templates, **they found a standardised way** to combine both sides’ unique expertise and create a common data structure that represented exactly what the contractor needed from the supplier and exactly what the supplier outlined as an important characteristic. This approach was discussed in terms of future integrations between the contractors’ and manufacturers’ databases that can allow both parties to achieve efficiencies through the management of up-to date data, automated procurement and industrialisation.

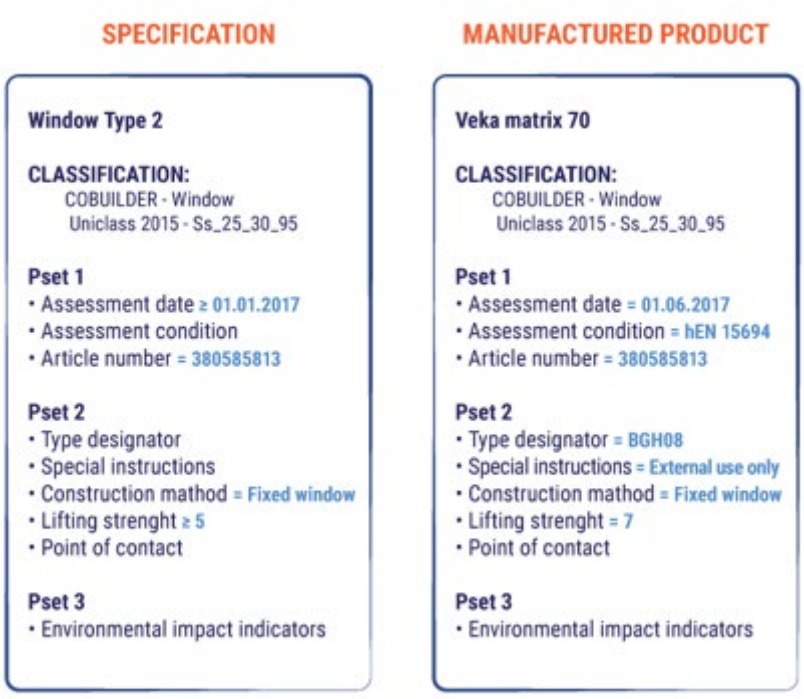


Illustration: Matching a specification with true data about a manufactured product. Cobuilder AS @ 1997-2019

Finally, while this project showed that contractors and their suppliers could largely benefit from finding ways to standardise the way they work with elements, there was a societal benefit to be found in the project as well. The accurate data that was attributed to the model ensured a continuous link between requirement and actual product installed, making sure the as-built product corresponded to the requirement. An approach that can create such results can be seen as an important step towards closing the huge performance gap that has been characteristic of the construction industry for many years.

External wall (One to many benefits)

Currently NCC is looking to further develop this effort towards the systems way of thinking. In contrast to traditional analytical procedures that are based on the idea that an entity can be resolved into and reconstituted from its parts, systems thinking focuses on the ability to analyse and perform problem solving in complex systems. It acknowledges the primacy of the whole and the primacy of the relation of the interrelationships of the system elements to the whole. [10]

A system is a combination of interacting elements organised to achieve one or more stated purposes and *produce results not obtainable by the elements alone*. A system may be considered as a product or as the services it provides [ISO/IEC/IEEE 15288:2015]

Having tackled the paperless workflow in the procurement of a single product (window) NCC is now looking at applying the principles of systems thinking to their processes and provide them with a way to describe and work with such combinations of interacting elements – i.e. systems of any kind, in a machine-readable, reusable and interoperable way.

If we consider an external wall as a system, composed of components such as mineral wool insulation, bricks and metal framing components, a contractor such as NCC, would need both information about the performance of the wall as a whole, and information about each component, too.

NCC is working towards minimising the amount of variations of building elements that they deploy in each project. Creating a standardised building elements library combined with the predictability that forming long-lasting relationships with suppliers and manufacturers brings, is key to improved time and budget control.

On the other hand, manufacturers of building materials do realise that their products are rarely used alone and almost always together with materials of other manufacturers, forming systems, on which performance they do not have control.

As the data template structure allows for modelling of systems through relating the template of the whole (in this case: external wall) to its components, it serves as a structured base on which such a standardised building elements library could be built.

What is challenging in the case, is that not only manufacturers need to agree with NCC what the necessary characteristics of each component are, but they also need to agree on the composition of each system, as well as agree on the performance that the combined interaction of their separate products would lead to.

For this, NCC, together with manufacturers of mineral insulation and bricks, have set up a small pilot and a sample template, where all involved parties can:

- agree on common building element configuration and definitions
- agree on necessary characteristics on a system level as well as on component level

The work is still in progress, but it would demonstrate the value of the next level of mutual agreement and understanding between manufacturers and contractors, that only standardisation can bring

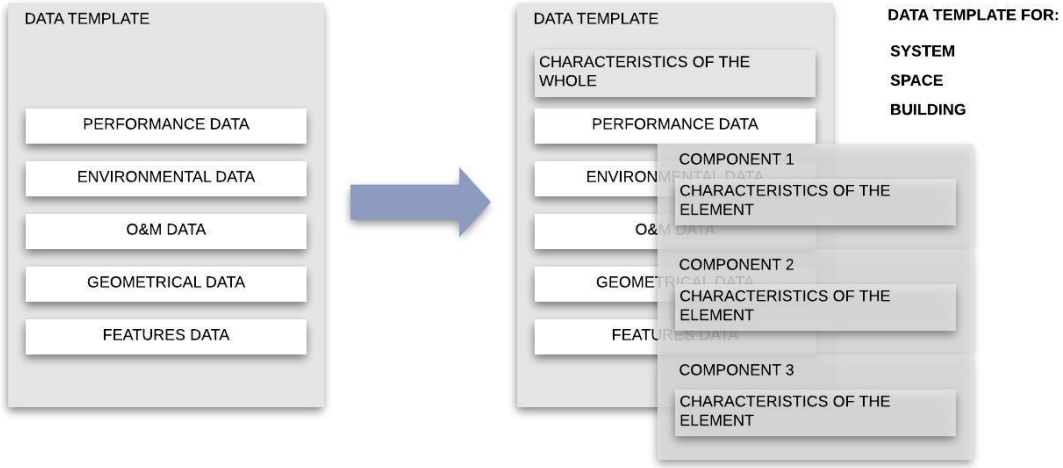


Illustration: Data templates can be used to standardise complex systems. Cobuilder AS @ 1997-2019

Forward-thinking information and communication technologies (ICT) providers

Although not directly participating in the construction process, ICT providers, through their modelling and information management tools, optimise processes for the rest of the actors. At the technological scene currently, there are many digital influencers who already have huge impact and will continue to do so even more on the introduction of digital supply chains in the sector. Construction Products Europe has recently commissioned a report that aims to collect all the different software available for construction industry actors at the European level. The report has shown that:

- The AECO market is fairly satisfied with the handling of geometry and is shifting demand to its next most pressing need, data management solutions;
- there are not enough data management solutions and software companies are rushing in to fill a niche with a lot of opportunities, given the large variety and specialisation of data;

Whatever the reason behind the shift, the trend is good as it shows market is adapting to a dynamic environment. Having more contributors work on data-centric tools and processes suggests that maturity close to the geometry's will be reached quickly. A small fraction of the contributors such as Cobuilder is already thinking a step ahead by aiming to cover the full scope of CEN TC/442 standards on structured data management.

Despite the good indicators, contributors must be wary of being trapped in "silos" where the different solutions cannot easily exchange data. This responsibility mainly falls on standardisation bodies, as they are the ones who actively suggest data structures, formats and workflows, but it does not exclude the software providers. The influence of software development companies such as IBM, Autodesk etc. makes it very easy for these technological giants to influence how many AECO actors participate in the digital supply chain. This can lead to a situation where standards and regulations suggest one way of working but the tools on the market support a different one. This will very likely create bottlenecks for data exchange that will diminish the advantages of digital supply chains. One straightforward approach to avoid this is to bring the standardisation bodies and software developers together. Currently there is a very small overlap between these groups and one of the reasons for this is the aforementioned perception that standardisation work is 'too complex' or a "closed shop".

The reality is that all of the standardisation bodies emphasise on market feedback in standard development and openly welcome business participation. Still, there is an unintended lack of transparency and publicly available information about the standardisation work. The market is often unaware of what standards are to be expected, how these may affect it and how can the development process be joined.

More guidance and active outreach on part of the organisations and more involvement on part of the software developers can increase the overlap between process and solution providers, thus mitigating the potential discrepancy between how things should be done and how thing can be done.

NCC Case Study

Integrated VDC with NCC

Business need

In order to drive efficiency throughout the entire organisation, the Nordic Construction and property development company NCC initiated several research and implementation projects to achieve a paperless workflow in all stages of a construction project. As part of their strategy, NCC set an objective to create a Construction Elements Database (CEDB) for storing the data collected through the new paperless process for the purpose of reusing knowledge and performing historical analyses. The Construction Element Database was intended as a data repository to be used across

four of the Nordic countries (Sweden, Denmark, Norway and Finland) in order to facilitate planning, procurement, calculation, cost control, production steering and FM.

Challenges

The lack of established common definitions and data structures creates a major challenge when establishing common processes for data management within international organisations such as NCC and impedes seamless data flow both across the organisation as well as with external stakeholders. To tackle these challenges, NCC set out to explore different options with regard to defining a data model that can cover the informational needs of all the actors involved, as well as ensure interoperability across borders and projects. NCC looked into using different classification systems, but since these are based on national standards and not universally used, the required mapping of properties between the different classification systems proved to be a difficult task, potentially creating further silos in the organisation's information management systems.

Solution

The solution to this issue was provided by the Data Template methodology employed by NCC as means of establishing a common technical language and a common data structure to be used across the entire organisation and with external stakeholders. Furthermore, by structuring their data with the help of Data Templates, NCC ensured that all the subsidiaries in the different Nordic countries could benefit from the information stored in the Construction Element Database. Data Templates are developed on the basis of existing standards, e.g. harmonised European regulations, such as the Construction Product Regulation (CEN), the Low Voltage Directive (CENELEC), etc. These standards provide clear guidelines on how to declare performance and intended use of construction products, thus establishing the required common technical language that can be used about any type of building element at different points in time, by various actors and across borders. In addition, Data Template are created within a common data dictionary framework according to the International Framework for Dictionaries (IFD), thus ensuring that the meaning of information stays the same regardless of semantics. By structuring their data in accordance to harmonised European standards, NCC ensured the information stored in the Construction Elements Database

The pilot project

To test the paperless workflow, NCC chose a Swedish project as the first pilot. The project focused on the procurement process and involved the window manufacturer NorDan. The information collected in the course of the pilot project was to be stored in the newly established Construction Element Database for future reuse.

1. NCC's data stewards were invited to use a solution for authoring Data Templates provided by Cobuilder, and gained access to a number of Data Templates with the possibility to make changes and additions to them, where this was applicable, in order to capture their own context. This process followed the guidelines put forward in CEN TC/442 prEN ISO 23386 & 7 ensuring that all changes go through a rigorous approval process and any new concepts or

concept synonyms are updated into bed - buildingSmart Data Dictionary so that the interoperability is always maintained. This allowed NCC to establish a reliable data model to be used during all data exchange.

2. The manufacturer NorDan was also involved in establishing the data model, and IFC was used as an exchange format to capture the data model's content and ensure the communication between the parties. This alignment ensured that data requirements on both ends could be united and translated through a data dictionary framework. Agreeing on the shared context, NCC identified all the properties needed by the organisation for the particular construction element, while NorDan identified the information that is required for them to be able to provide a price quotation, and later on – to manufacture and deliver the products.

3. Sets of required data were created to be used for different purposes/needs, at different stages, required by different actors. These requirement sets utilise the Data Template structure, but in this case to manage information requirements. Different requirement templates can be distributed to different involved parties so they can supply, edit or enrich the needed information within the template. As a result of this, procurement flows were much easier as suppliers could provide offers based on requirement templates to NCC, and NCC experts could easily compare between different suggested products.

4. Having established the common data language and structure by employing Data Templates, NCC applied IFC as the common format for the information exchange. The following workflow was executed:

    - NCC could establish the data requirements for a particular building element in order to meet the informational needs of the design team.
    - The design team could enter some specification values and then assign the need for more accurate specification to the manufacturer.
    - Based on the specification, the manufacturer is able to identify the products that match the project requirements, and return the information, within the same structure and format, as relevant proposals giving the design team the opportunity to compare the suggested products and select the one that best meets their criteria.
    - The design team was able to make an informed decision and specify a construction product, and then return the information to the contractor.

Results

By introducing this new data management process, NCC has come a long way in achieving the goal of a paperless and more efficient design, calculation and procurement workflow. Through this pilot projects, NCC was able to drive efficiency both by reducing time and wasted within internal processes

in need of optimisation. The digital information exchange utilising a common technical language lead to a reduction in errors, consequently minimising the risk of making changes at a later stage of the project which invariably leads to delays and increased project costs.

On the manufacturer side, NorDan reported that by early involvement with Data Templates they got correct data that secured the correct product and reduced both time and cost.

Through using Data Templates to provide the structure and language for digital data exchanges between the different actors, NCC was able to maintain the 'golden thread' of information and thus continue to draw benefits from standardised, interoperable data throughout the project. NCC was also able to enrich their Construction Elements Database (CEDB) and store all data for the purposes of historical analysis and reuse of knowledge. The Data Template specifically created for this pilot project is to be used across the entire organisation on all projects.

This approach allowed for potential database integrations with strategic partners to achieve further automation.

Key Learnings

- The construction industry is very fragmented and with big range in digital competence. The different actors are mostly focusing on their own purposes and very few see the whole picture and complexity of completing a construction project with all their actors. The result is that for all the actors there are a lot of manual, time consuming processes that need to be done to get the right data in the different systems. It will require collective adaptability and competence raising in order to have a fully digital industry.

- The use of Data Template with standardized data gives a lot opportunities, increase efficiency, can be used in all countries, by all parts in the value chain, it reduce risk, time and cost for all. Standardized data is one the cornerstone to secure digital supply chain and efficient sharing of information that could be/are machine readable.

- The design, calculation and procurement process become more efficient (2 days to 4 hour). It will increase the efficiency in our other internal processes and with external partners. It secure which data we need to the different purposes that we can connect to time management system and roles. We will then get correct information flow (ISO 19650) that secure that decisions are taken at correct time.

- It gives the opportunity to automatically perform environmental analysis like Carbon Foot Print and we can check that products are according to legislations, Smart CE marking, Reach etc

- Data Template will hold logistic data that secure traceability from the manufacture to site, on site and secure that product is mounted on the correct place. We can then use the GS1 standards since we can connect the generic ID with the actual product GTIN and follow it the hole way and give the customer a barcode, RFID that makes it very easy for the customer to get the correct information on a product when they need.

- This will also give the customers a digital twin with the same data (FM) in all their projects and a important foundation for big data.

Conclusion

This whitepaper discusses that in order to create and sustain digital supply chains, the construction sector needs to ensure that building actors are aware and can easily step in on the existing industry standards related to **#1 Standardisation and Interoperability of product data** and **#2 Digital Product Identification**. This is how they can fulfil not only the requirements of identification but also the requirements for regulatory compliance and information exchange. The potential collaboration between companies such as **the ones taking part in the DSCIBE Group** can prove to be a major driver for the digitalisation of the construction industry. This is especially important now that the need for digital supply chains is growing. With the rising demand for purchasing building materials directly online (through the Web and mobile apps), the industry now stands at an inflection point, where these standards need to be largely implemented in order to build a firm basis for the future benefits of digital supply chains.

How to respond to this document?

We would like to encourage people and organisations from across the industry to respond to this document and provide their views on the notions put forward.

Please send your responses to the workgroup to fredenlund@cobuilder.com | aidan.mercer@buildingsmart.org | enzo.blonk@gs1.org

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Resources

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