



THE CLIENT'S USE OF ICT AND OPENBIM

A guide from buildingSMART Denmark



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Foreword

Most industries have achieved great increases in productivity through digitization. This includes the construction industry, where there are many opportunities for digital collaboration that can, among other things, increase productivity and quality, as well as make the construction industry more sustainable – thereby generating greater value.

The technology in and of itself does not contribute to this increase alone. If you as a client want to reap the highest benefits from a strengthened digital collaboration, there has to be clear and well thought out requirements for digital services. You must as a client continually follow up on whether you are receiving the services and deliverables you are requiring and are paying for.

It is no secret that digital development is moving at a fast pace. A requirement that is relevant to set today may not be as relevant tomorrow. This can be a challenge in an industry where construction projects often run over a number of years, from the time of the initial sketch to a completed building – not to mention the continued operation and maintenance. Requirements for digital collaboration should therefore be within the broadest possible scope based on the fact that there will be a development.

As a client you must therefore have a clear and robust strategy for digital collaboration and set requirements that both allow the possibility to take advantage of technological development, and that take into account any change of parties on the project at some point in the process.

The strategy will always be dependent on your needs and ambitions as a client. The same applies when it comes to setting requirements for digital services. Digitization should not be a goal in itself, but a means to achieve tangible benefits for both the client and the construction project. For example, it could result in an increased quality in the consultancy project or a minimization of waste during the execution of a project.

The goal of this guide is to give the client, as well as other parties in the construction project, a short and simple introduction to what is relevant to consider when requirements are being set within digital collaboration, specifically with the use of ICT and openBIM.

Enjoy!

What is BIM, openBIM, IFC and buildingSMART?

On a construction project different parties will exchange a lot of information and digital deliverables. This is often facilitated using Building Information Modelling – abbreviated to BIM. BIM is an information based collaboration method applying digital models to facilitate knowledge- and information sharing between stakeholders connected to construction projects¹.

To ensure an exchange of information can occur effectively and without the use of a specific software, it is crucial that the information be delivered in open formats – also called openBIM.

Industry Foundation Classes (IFC) is a file format that is developed for exchange of information between parties in the construction project across software platforms and is an example of openBIM.

In Denmark it is a requirement that digital models are exchanged in an IFC-format on public construction and public housing projects.

The construction industry has through the organization buildingSMART International developed universal standards and tools for effective exchange of information about building, construction and infrastructure across the parties' digital tools. OpenBIM is in this regard the central concept in buildingSMART, as a vendor neutral collaboration process, with project information and data that support seamless collaboration for project participants.

buildingSMART is leading the development of common openBIM standards and tools that support interdisciplinary collaboration and open data exchange between an entire construction project's value chain and throughout the life cycle.

See moreover the case with the University of Copenhagen in chapter 4.

¹ Nicolaus Falk-Scheibel has in his PhD dissertation "Digital Construction Law – Building Information Modeling – interpretation, behavioral norms, services and liability" from 2022 pg. 36 defined BIM as: "BIM is an information based collaboration method, applying digital models to facilitate knowledge- and information sharing between stakeholders connected to construction projects."



1 The client sets the framework

As client it is you – as the appointing party and via requirements in the tender material – who will set the framework for the digital collaboration between parties on a construction project.

IKT-specificationen

Currently a client's requirements for ICT typically get set through an ICT-specification². As the name implies, the purpose of an ICT-specification is to specify the ICT services that you as the client want to be delivered.

Most ICT-specifications are developed based on the Danish Association of Consulting Engineers (FRI) and Danish Association of Architectural Firms description of services for BUILDING AND LANDSCAPE 2018 (YBL 18). YBL 18 contains overall descriptions of ICT management and ICT services. Therefore, you must supplement YBL 18's descriptions with a separate ICT-specification for the specific project, and potentially also with other requirements, for example requirements about which IFC format you want to receive.

The ICT-specification sets the client's requirements for digital collaboration. It is essential for the scope of the consultants' and contractors' digital work and is therefore included as a foundation for the consultant's agreement and the construction contract.

ICT process manual

In practice the need will often arise for parties in a construction project to coordinate their digital services, especially if the contractor is to design. This can be done in a process manual for ICT which the ICT manager will create, and which should be in accordance with the other parties on the project. For example, Molio's paradigm for ICT process manual A402 could be used.

The ICT process manual is a process document that dictates how a ICT-specification is put into practice. Since the ICT process manual often will contain instructions for all parties on the project, you should, as a client, always show an interest in the actual content of the ICT process manual.

The ICT process manual can be created after an agreement has been reached and is a document that can change in line with the development of the collaboration, new partners entering the project, or with new software being introduced. The ICT process manual should only include instructions/recommendation for agreed upon collaborative processes, since actual requirements for project partners should be outlined in the ICT-specification.

Hvad er ICT?

With construction in Denmark the term ICT is typically used when talking about digital collaboration methods. ICT is an abbreviation of Information and Communication Technology.

Requirements for ICT cover many aspects of digital construction, for example how parties communicate digitally on a construction project and who has the responsibility of managing the work concerning ICT on the construction project.

It also includes requirements for the formats data and information shall be provided in among others.

² Previously the ICT-specification was also called an "ICT-agreement", but in this guide we only use the term "ICT-specification" (Molio A102).

2 Legal framework and agreement setup

ICT regulations

This necessitates that public and public housing project clients with construction projects of a certain size set requirements for, among others, construction models, digital tenders and offers, as well as digital delivery and handover.

There are two ICT regulations that have been prepared on the basis of prevailing law in regard to public construction and public housing projects respectively. The central content of both regulations is identical.

With construction projects involving renovations you can as the client choose not to fulfill one or more of the regulation's requirements if the costs of certain requirements doesn't measure up with the benefits. This does, however, not include requirements concerning digital tenders and offers.

If you are a private client these requirements doesn't apply to you. You can, however, gather inspiration from the ICT regulations and Molio's ICT paradigms as they give a good indication of what ICT requirements are relevant to set for construction projects. Molio's paradigm for ICT-specification fulfills the requirements listed in the ICT regulations.

The ICT regulations apply when the state is the client for a construction project - including both new construction and renovations - that have a contract sum of at least DKK 5 million, or if the state is contributing more than a 50% subsidy for a construction project, or for subsequent maintenance of a construction project with a corresponding contract sum. For a regional, municipal, or public housing project the above also applies, but concerning these types of projects it is a minimum contract sum of DKK 20 million that applies. All amounts are exclusive of VAT.

Public and public housing clients must, in accordance with the regulations, ensure the coordination of the joint use of ICT, and that there are set requirements for the following:

- Coordination of common ICT usage between all involved parties.
- Handling of digital construction objects.
- Use of digital communication and a communications platform (project web).
- Use of digital building models during project competitions, processes, and actions.
- Use of digital tenders and offers.
- Digital delivery at handover of the building.
- Use of digital defect lists.

See link to download the ICT regulations at the end of the guide.

³ICT regulation no. 118 of 6 February 2013 on the use of information and communication technology in public construction projects and ICT regulation no. 119 of 7 February 2013 on the use of information and communication technology in public housing construction projects.

The agreement with consultant and contractor

In the agreement with the technical consultant the ICT-specification will be a further elaboration of the services the consultant must deliver in accordance with YBL 18. You can supplement the ICT-specification with other services, for example using inspiration from the DS/EN ISO 19650 standards.

In the agreement with the contractor the requirements in the ICT-specification will be dependent on the scope in which the contractor must deliver digital services to the project. It will typically be relevant to set requirements for digital handover and digital defect lists. If the contractor is carrying out design work, it would, for example, also be relevant to set requirements for the handling of and use of building objects in digital building models with, among others, classification, quantities, property data and information.

AB 18, ABR 18 and ABT 18

Agreements with the technical consultant and contractor/turnkey contractor will often be based on ABR 18, AB 18 and/or ABT 18 respectively, which all contain requirements for digital building models (ABR 18 § 15 and AB 18/ABT 18 § 16).

Requirements in ABR 18/AB 18/ABT 18 set the framework for what you need to consider in the agreement with the consultant and contractor if you use digital building models. You must, among other things, indicate for what and in what scope the models can be used. For example, if the digital building models (both federated and discipline models) can be used for quantity take-offs, or if the discipline model can form the basis for routing or not.

ABR 18 § 15 and AB 18 § 16 furthermore establishes that every party is responsible for their own input, interfaces for other parties' design in the model, and for their use of the models.

The ISO 19650-series contains recommendations for concepts and principles for the business practices that support the management and production of information in a building's life cycle with the use of digital building models, which includes management of quality requirements for data and information.

ABR § 15, AB 18 § 16 and ABT 18 § 16

All three resolutions contain requirements for the determination of the following in the agreement:

1. What and within what scope the models should be used, which includes whether they should be used during planning and project execution.
2. If there, at the completion of the construction project, should be delivered a digital "as built" model for later use and potential reconstruction.

Furthermore, ABR 18 § 15 and AB 18 § 16 contain requirements to ensure instruction must be given on what the models are permitted to be used for, and if the data must be delivered in open format.

3 What should an ICT-specification specifically include?

Many clients have an ICT-specification they, as a standard, attach to agreements. You should, however, not attach it blindly, but always adapt the content to a specific project, so you only set relevant requirements that you wish to pay for.

Moreover, it is important that you as a client attempt to understand what requirements are set in the ICT-specification for consultants, and later for contractors and suppliers. You shouldn't necessarily have to understand all the technical components in the requirements. You simply must understand why a requirement was set, and what its' expected output is. This way you ensure the requirements actually are valuable for both you, the project and the subsequent operation.

Finally, it is important that the ICT services are distributed between parties in the ICT-specification, so it is clear whether it is the consultant, contractor or you as the client that must deliver a specific ICT service.

In the following, we go through the regular requirements for an ICT-specification with the YBL 18's conditions as a foundation. We will also highlight when a requirement is relevant so you, as the client, can be even more prepared for the establishment of ICT-specifications for a specific project.

As a client, you must for every service within sec. 9.1-9.10 in YBL 18 decide whether you want the service in question. If you are a client for a public project or public housing project, you have to be attentive to whether it is a requirement for you to include the service as per the ICT regulations previously outlined in chapter 2.

If you want one or more of the services in the description of services of a construction project, you must determine definition and scope of the service with in the contract with the consultant within the ICT-specification and in the YBL 18's schematic definition of consulting services. A consultant to the client with insight in ICT would be able to help with this.



3.1 ICT management

When you are setting requirements for ICT on a project, it is relevant to consider how you will organize and coordinate the work with ICT on the project. This is especially important when there are several parties involved in design as ICT initially is closely tied to the process of design. However, it is also relevant during the execution phase if the contractor is delivering services digitally.

Therefore, it is affirmed in the ICT regulations § 3 that you, as client, must ensure that there is coordination of the complete ICT usage between all involved parties during the entire duration of the project.

You can ensure this through the appointment of an ICT manager. The ICT manager's primary assignment will be to establish and lead the construction project's ICT organization, and ensure the digital collaboration is controlled in accordance with the requirements in the ICT-specification. The role is described further in YBL 18 sec. 2.2. As client, you can decide if a consultant should take to the role of ICT manager, unless you wish to take on that role yourself. Within main contracts it would be more appropriate to let a consultant be the ICT manager, as the service is closely tied to overall project management. You can also consider whether ICT and project management should belong to another consultant than the one in charge of the design.

Molio instruction A305 ICT Project Roles define what ICT project roles a construction project should have based on the "Description of services for BUILDING AND LANDSCAPE 2018". A305 describe the following ICT project roles and briefly exemplifies the tasks of the project roles:

- ICT manager
- ICT project coordinator
- ICT professional field coordinator
- ICT consultant to the client

See download link for Molio's instructions at the end of the guide.

The ICT manager should be assigned to the design management team and participate in all design meetings, as ICT will often be thoroughly integrated into the design process. For example, collision control is always a very important topic to bring up at design meetings. It is therefore rarely feasible to have separate meetings about ICT and design on a construction project.

The agreement regarding ICT leadership can be included either in the ICT-specification or the consultant agreement, for example with the use of the schematic definition of consulting services in YBL 18.

There will typically be appointed an ICT coordinator for each individual professional field which would mean there is a representative for each area that is responsible for ICT. This individual will confer with the ICT manager who coordinates the collaboration on the highest level.

It is also the ICT manager who creates the ICT process manual. It would be pertinent to make demands for the creation of an ICT process manual, as it is an important tool used to support the digital collaboration between parties attached to the project. It is within this manual described how the requirements of the ICT-specification are to be executed in practice.

To ensure the requirements within the ICT-specification are upheld on the project, the ICT manager can continually adjust the ICT process manual so it provides an accurate representation of the collaboration. The ICT manager should always keep an eye on changes that might have consequences for time or budget of a project, as any changes in this regard would require the approval of the client.

Even though the ICT process manual is a practical document that typically is used between consultants and contractors, you should as the client keep yourself well-informed of its' content to ensure it upholds the ICT-specification, and that it doesn't include requirements that either are unnecessary or instead should be included in the ICT-specification.

3.2 Classification, identification and level of detail

When design occurs digitally it is through the use of digital building objects (BIM objects). Digital building objects can perhaps best be described as a sort of “building block” that can be supplied with different data and information.

To ensure these building blocks are readable across different software programs and file formats, it’s important that they get categorized (classified) and identified (type and location specific) from some already established criteria. For building objects, a classification could be “wall”, “door”, “window” or “ventilation aggregate”. Identification could be that a particular door is placed on the front of the building.

Therefore, it is determined in the ICT regulation §4, that a client must set requirements that ensures digital building objects throughout the construction project are structured, classified, named, coded and identified uniformly at a particular level of detail, and that there are set guidelines for handling them.

Molio instruction A102 ICT-specification dictates that the goal of classification and identification is to create cohesion in the project material in the process of design, execution and completion. This occurs through construction works, parts, systems and rooms being classified and identified.

See download link to Molio’s instructions at the end of the guide.

Classification is a service a client can order with a consultant in accordance with YBL 18 sec. 9.1. If there is design digitally, it is relevant to order this service, as it is important that everyone on the project effectively can use the data and information that is a part of a digital building model.

In the ICT-specification, you, as the client, should therefore decide how building objects should be classified, and thus also what classification and identification system should be used. You should also define the purpose of the scope of the classification as it will make it easier for a consultant to classify in a meaningful way.

For a client and operations manager, it will be an important goal concerning the system of classification to ensure that building objects are provided with information and properties that are relevant for the construction’s future management, operation and maintenance. It is within this process that digital design really has the potential to create value in the long-term, especially with the creation of plans of operation and maintenance and potential later renovations.

It is, in this case, also important that you, as a client, consider the scope and level of classification, so you don’t make more demanding requests than necessary concerning scope and level of detail.

The chosen level of detail for BIM models is crucial to how comprehensive the work of creating these models will be. The level of detail includes both the detail of the geometry, as well as the number of properties and information that should be tied to the model’s 3D objects. Level of Detail is often abbreviated (LOD) and can be found in the “Building Sections Specification” from Molio/Dikon/BIM7AA (see link at the end of guide).

It is the project type, form of enterprise, and your needs as client for the use of the digital building model that will decide the degree of detail for classification and identification, and the level of detail for 3D geometry and property data.

Often a large portion of the data used for the actual construction will rarely be relevant for the following operation of that particular building. It is therefore important that you, as client, consider the needs of operation already within the development of the ICT-specification, so that the requirements are adapted to the output that makes sense for operations. For further information, see the case with the University of Copenhagen at the end of this guide.

During design it is important that you continually follow-up to ensure building objects get classified as agreed upon, and at the same pace as the project is being designed. This is a way of ensuring that the classification is occurring as planned and is of satisfactory quality.

You should always consider classification, identification and level of detail for a given project, and include those decisions in the ICT-specification as these requirements are essential to the consultant's workload and thereby their fees.

The Danish Building and Property Agency share their experiences with ITC, including classification and identification on their website under the heading "Construction and Guidelines for ICT services". They write:

"In the Danish Building and Property Agency's experience, classification and identification should be applied the moment a part of a construction project is being designed. Consultants and general contractors can have many reasons to postpone this service, but it rarely ends well. The handling of classification and identification can become unmanageable, a heavy workload and a generator for unnecessary conflict. Slightly naively, it can be compared to writing a 300 page report, where the author postpones adding commas and full stops until the end. Despite challenges with the aforementioned approach, it is our opinion at the Agency that it ensures a streamlined and stable classification and identification system, while saving the project designers from a heavy clean-up."

See link to the Danish Building and Property Agency's website at the end of the guide.



3.3 Digital communication and the establishment of a communication platform

Currently, the communication on many construction projects occurs digitally with the use of email and typically also a project web, which collects all project documents and ensures file exchange.

A project web gives all parties the possibility to access the same material so there is clarity as to what material should be used as the reference point for construction.

The larger a construction project is, the more files and communication is needed. It is therefore always pertinent to consider how you should be communicating digitally. This isn't just significant for the efficiency in communication during a construction project, but also for pertaining to continual archiving so that in the event of, for example, disagreements concerning what is applicable, approved or agreed upon, is it easy to find the documentation.

It is therefore important that you, as client set requirements in the ICT-specification for digital communication. This applies to both written communication, file sharing, file and mapping structures and use of metadata, as well as how a shared communications platform is established - and in this case how it should be established, administered, and operated in accordance with YBL 18 sec. 9.2 and 9.3.

It is you, as the client that makes the decision on whether a digital communications platform should be used on a construction project. The decision will be dependent on namely the project's size and complexity. With larger construction projects it will likely be valuable, but it could also pay off with medium-large sized construction projects, as the platform could contribute to ensure streamlined communication, archiving, and easy access to project documentation.

Concerning the establishment of a communication platform, there are two particular questions that are important to consider:

1.

Who should make the communications platform available?


Here it is important that you, as the client - if you are not the one to make the platform available - ensure yourself full access and rights to the content of the platform, even after the construction project is complete. For it to make sense you, should also ensure that the content can be opened in regularly used programs.

2.

What function should the communication platform fulfill?

Should it be used for file exchange and archiving, or should all communication be facilitated through the platform, so email is banished? Should it also be able to show BIM-models? Should it only be used in design process, or should it also be used during the execution for technical queries, etc.? Should it moreover be able to be used for supervision and collection of operational information, as well as be able to be converted to an operations platform when the construction project is complete?

If you aren't using a communication platform, or if you only are using a communication platform for file exchange, it would be pertinent to set requirements for how written communication should take place and how the project documentation should be named, structured, versioned etc. This especially applies if you as the client have the need to archive in private, internal systems. This can ensure the documentation more easily can be found.



According to ICT regulation § 5, the client must set requirements pertaining to the use of a system for digital communication and archiving of all relevant information in the duration of the construction project, and that there is an established plan for how the system of digital communication should be used. The ICT regulations § 5 sec. 2 sets requirements for the client to ensure that there is an established plan for which parties should make what information accessible at what level of detail and at what points in time. The client must also determine which file formats should be used, and what metadata should be tied to the individual types of files.

See download link for the ICT regulations at the end of the guide.

Where the ICT regulation sets the requirements for the digital communication, it is the ICT manager's task to ensure the ICT-specification's requirements technically and practically are expanded upon in the ICT process manual in accordance with YBL 18 sec. 2.2.

3.4 Digital design

Digital design involves the use of BIM, which encompasses digital object-based building models within design and execution.

If the project is covered by the ICT regulation, you must, as client during design and execution set requirements for the use of object-based building models in accordance with ICT regulation § 7, unless the costs in this regard outweigh the benefits in accordance with ICT regulation § 2.

Discipline model and common model

With the use of object-based building models there is a differentiation between a discipline model and common model. The discipline model is, as the name indicates, a building model specific to a discipline professional field, for example plumbing installments or constructions, while the common model encompasses all discipline models.

The development of digital building models as the foundation for coordinated design is a service normally ordered from a consultant, see YBL 18 sec. 9.4. Concerning the main contracts with the contractor design, the contractor is tasked with creating discipline models that can be included in the common model.

Consistency and collision control

One of the great benefits of using object-based building models is that the consultant can during design and within execution perform comprehensive quality assurance, for example with collision and consistency control when all discipline models are gathered within a common model. This means the consultant early on can discover, for example, that piping for electricity and plumbing is placed on top of each other, columns are placed in front of doors, two rooms have the same room number, wheelchairs can't turn in the disabled toilets, or ramps are too steep. Naturally, it is essential that the consultant not only performs consistency and collision controls, but also corrects all major errors before the execution of the project. It is therefore important that you, as the client, set requirements for collision and consistency control, as well as requirements for documentation of corrections of ascertained mistakes.

It can be advantageous to set requirements to use an issue management system, where the consultant creates, delegates and documents mistakes found while performing quality assurance. Such a system often synchronizes the error reports in "the cloud" across both BIM programs and quality assurance systems so multiple parties can access the list of errors from an internet browser during design meetings.

Building models' usage, level of detail and structure

According to ABR 18 § 15, sec. 1, AB 18 § 16, sec. 1 and ABT 18 § 16 you should, as client, ensure that there both in the consultant's agreement and contractor's agreement is established parameters for the use of the digital building models and the scope of their usage. This includes both how they should be used for design and execution, and if there should be provided an "as built" model at completion⁴. In practice, this will often happen in the ICT-specification, where it also is specified which discipline models that should be delivered at what level of detail (LOD) and in what phase of construction. It is obvious to use the Specification of Building Parts, which is created in collaboration between Molio, BIM7AA and DIKON.

In the ICT-specification you should also specify how building models should be built and structured, and what file format they should be made available in, as well as how quality assurance (consistency and collision control) should be executed and documented. The goal is to set the scope of the digital services. As client, you should always describe how controls should be executed with the delivered documents and with random samples for quality assurance.

Precedence and delegating responsibility

If there both is the use of drawings and building models, you should within the agreements with the consultant and contractor respectively decide on which project material takes precedence over the other in the case of discrepancies. If a specific decision is not made it will follow the rank of ABR 18 § 4, sec. 6 and AB 18 § 6, sec. 3.

⁴Newest Danish guide for "as built" is Guide for "As Built" 2022. There is a guide for FRI's and Danish Association of Architectural Firms Description of services for BUILDING AND LANDSCAPEs (YBL) and FRI's Description of Services for CIVIL WORKS (YBA).

The overarching principle for delegating responsibility in the establishment of digital building models is that every party is responsible for their own building models, see ABR 18 § 15 and AB 18 § 16. It is the ICT manager that prepares, updates and combines the common model for tender, design, and execution design, see YBL 18 sec. 5.7 and 6.7. It is the design manager in conjunction with the ICT manager that must ensure quality assurance and that the consistency and collision control is completed, see YBL 18 sec. 2.1.6. Molio has created the guide C402 Consistency Control of Building Models (see link to Molio's instructions at the end of this guide).

Open formats

Finally, it is also important that you as the client set requirements to ensure the digital building models, as well as all other documents, are exchanged in open formats, which means file formats that can be exchanged regardless of what software model other documents are created in.

Examples of open file formats include:

- IFC (BIM)
- BCF (error reports)
- PDF (print)
- DXF (CAD)
- JPEG (pictures)
- MP3 (sound)
- MPEG (video)

The open formats are advantageous as they can be shared across different software platforms. In practice, it is apparent it will be easier to access many years in the future compared to software specific (proprietary) file formats.

It is important that all parties on a construction project initially can use the software they are used to, and that is most appropriate for the individual to work on the project in. However, the open formats still ensure that the client in their own operating systems, and even years after the construction is completed, can open and

use the building models regardless of the software program it is created in or the eventual new systems that could be used in the future.

Requirements for open formats can be set in the ICT-specification by you as the client requiring that all digital building models have to be accessible and delivered in a particular IFC format. ICT regulation § 7, sec. 2 sets this exact requirement; that a client must ensure that building models are accessible in an IFC format.

The IFC format

Regarding the IFC format you should as client be aware that multiple IFC formats exist, as the format continually is updated. Therefore, you should carefully research which version is relevant for you to use.

IFC 2x3 is an openly accessible file format, but also a ISO/CEN standard, that is well suited for exchanges involving coordination and quality assurance of BIM. As the format has been in use for many years it is this version of IFC that is most widely used and generates the fewest mistakes when importing and exporting between different BIM programs (October 2023). The format doesn't have the same capacity for supporting infrastructure projects, as well as information for the calculation of life cycle (LCA) or total cost (LCC) as the newer file format IFC 4.3.

In Denmark there has since 2023 been implemented requirements for documentation of life cycle calculations (LCA) for all new buildings. Information for the LCA calculation is ideal for exchange in the IFC format, where it is possible to store information from products' sustainability description (EPD), for example life expectancy and CO2 footprint of materials.

3.5 Digital tenders, offers and bill of quantities

Currently digital tendering and offers has gradually become a natural part of the tender process with public and public housing project clients. According to ICT regulation § 8 an obligatory requirement applies, where clients must use digital tendering and offers in the procurement of construction works, facilitated by a digital system.

Tendering portal

In the ICT-specification you must as client determine what digital system (tendering portal) should be used for the tendering and offer process, and how the tendering portal should be provided, financed, and administered, see YBL 18 sec. 9.5. You must do this to ensure the consultant understands the scope of the digital service.

It will typically be the client that provides and finances the tendering portal, and the technical and/or legal consultant that will administer the tendering portal as a part of handling the tendering process on behalf of the client. There exist several standard tendering portals that can be used.

Procurement with quantities

Digital design makes it possible to procure with quantities, where it is possible to extract specific quantities from the digital building model. Procurement with quantities necessitates that offer lists are created with certain quantities and that the particular method of measurement is explained. This service is more thoroughly determined in the ICT-specification, see YBL 18 sec. 9.6.

Digital building models should be modelled with the correct level of detail (LOD), and structured, classified, coordinated and quality assured before you can trust the result of a quantity take-off. It is therefore important that the service is clearly defined in the ICT-specification and ICT process manual, and that the ICT manager controls the process, as well as the client following up to ensure that requirements are being upheld.

Quantity take-offs should always occur in the same open IFC format, as different program specific formats can calculate quantities differently.

Molio's rules of measurement A310 set the conditions for measurement and can establish the foundation for unambiguous cross-disciplinary communication. Molio's rules of measurement concern many types of measurements (including amount, length, area, and volume). It is, however, not to be confused with what the measurements contain, or what particular service is tied to these measurements, as this information should be found in other parts of the project material, for example in the building element specification. The assortment of rules of measurement is continually being expanded, so Molio's rules can support the need for rules of measurement in the construction industry.

See download link for Molio's instructions at the end of the guide.

3.6 Digital delivery and digital defect lists

If you, as the client, want to reap the rewards of digital design, it is important that you include the operations manager and their needs when creating the ICT-specification. This particularly applies to material, quantities and information that has to be transferred to operations with the completion of a construction project, so the data can support future operational and maintenance activities.

Five larger digital clients and operations managers have shared their knowledge and experiences in Molio's instruction A845, where with examples and instructions they give insight into a method to uncover needs in building operations and ensure the correct information is collected and shared when delivering a completed project.

See download link for Molio's instructions at the end of this guide.

In the ICT-specification you should, as the client, determine if there is digital project material that needs to be collectively delivered with the completion of the construction project, or if there needs to be delivered a digital "as built" model - and in this case further specify. You must also determine if there must be delivered documentation and information for the products and systems that are used in the construction project, and if so how they should be delivered.

It will often be an advantage, especially with larger construction projects, to use digital defect lists to handle observed defects up to, during and after the project is handed over. Taking inspiration from Molio's instruction U106, Digital Defects Lists, it can be executed in a simple spreadsheet or in a digital defect management system. If the defect lists are to be able to be used in a digital system, you must use shared vocabulary and data structure. See the University of Copenhagen case at the end of this guide.







4 Case

openBIM contributes to valuable learning at the University of Copenhagen

University of Copenhagen is a client and operations manager that actively works with ICT. In the last few years, the university has gained valuable experience that they are sharing to inspire other actors. In this case Clars Danvold, group manager and chief consultant of digitization at KU, and general contractor Johs Konnerup Schultz explain how the focus on BIM requirements and processes ease the transfer of relevant area data for operations and maintenance of the university's many buildings.

The purpose of the ICT requirements at University of Copenhagen (KU) is to ensure the university's organization of operations has valid and usable data for daily operations and maintenance. The educational institution's sharpened focus on ICT is a part of a comprehensive development process, where BIM is playing an increasing role in the operating organization. Initially KU has focused on area data, which is a small part of the potential documentation of operations. Nevertheless, the focus on area is a good place to begin for KU's current implementation process of BIM for operations and maintenance.

Clars Danvold is group manager and chief consultant of digitization at KU and explains that the university is undergoing a larger adjustment process.

"Our first experiment with BIM clearly shows that we are learning valuable lessons about processes of transference. We receive some models that we dive into and see how much we can use to run operations and maintenance in the most efficient way," Clars Danvold introduces. "I have been proved right that a well-executed digital handover requires a well-defined process, a clear delegation of responsibility and certainty in ownership. Resources trump for current specifications, standards and manuals. At KU we don't have complete knowledge of organizations that have completely reached their goal of transferring BIM models from design to operations. So if there are construction or operations managers that have experience with this, we would like to hear from you," encourages Clars Danvold. Currently KU is working toward transferring the BIM models' area data⁵ from consultant's design to client's operations and maintenance at a large laboratory construction project, as well as at the Museum of Natural History.

Researching how BIM creates value

At the laboratory building the digital transfer of data has worked quite well. "We are collecting and receiving operations data that we thereafter investigate in a team that consists of both individuals working with operations and ICT. Furthermore we have a good project lead that has ensured the necessary forward momentum. To a great extent it is about agreeing on the responsibility for directing processes and follow-ups," Clars Danvold explains. "As an organization we have no ambitions to become "first movers" on BIM and ICT. This is due to, among other things, that parts of our building complexes are very old, and we don't want to use unnecessary resources on something that might turn out not to work. But on our new buildings we have transferred area data from BIM on 25% of our collective construction portfolio. We see increasing quality and consistency in the models, and we are very interested in finding out what value BIM can have for both continual operations and maintenance, and as a foundation for future construction projects - both with renovations, remodeling and extensions. Here it is essential that with the comprehensive examination of operational documentation we receive that we ensure that we exclusively receive operations data that really supports our work."

Increased digitization of operations and maintenance

The university uses MainManager as its FM system⁶ and this FM system must have the right information input.

"For an operation manager like us, it is important to for us to have a grip on the designs. Here "space management data"⁷ is foundational for many assignments, both concerning construction projects, operations, planning and administration. Therefore, our current focus is on area data in the form of interactive designs in the FM system," explains Clars Danvold.

"There is an estimated 32,000 rooms at KU. It will take an entire year's worth of work to execute continual corrections to floorplans so that our area database always is updated to account for remodeling - with so much square footage in use there is a constant need to, for example, move walls, combine rooms or complete internal moves."

⁵ Area data is data that gives an overview and information about existing areas

⁶ A FM-system is a system for Facilities Management, which means operations and maintenance of buildings

⁷ Space data management is a term for active decision making concerning existing areas/volumes

Digitization saves time and money

When KU receives BIM projects with the rest of the operations data, they hope to continuously automate the creation of polylines⁸ and DWG-filer⁹ in MainManager. Especially with the functions developed specifically for KU, it means they can't import IFC directly to the FM system. The solution has been to instead create polylines and area texts in DWG format from the BIM projects' IFC files.

To convert the IFC files' room objects to polylines, the consultant will import BIM projects manually and they will be corrected and exported in DWG format. "In Archicad¹⁰ 10 we have been able to generate polylines from IFC files with both net and gross area. There is a room stamp, but it isn't quite as it should be in the mandated AutoCAD Block.¹¹ Therefore we copy the information from the room stamp to our Block in AutoCAD, so it is placed exactly how our FM system needs it to be. There are still many functions in this process that we aren't finished experimenting with, and we hope to automatize even more in the future," says Johs Konnerup Schultz, who is the building constructor at KU.

"It would have taken a long time to make room plans in the laboratory building using the old method," Johs Konnerup Schultz further explains. "It took us multiple months to make area information for the FM system from 2D drawings with the large laboratory project. At the Museum of Natural History it took us some weeks to invent and polish the method to import from IFC, but afterward it only took two weeks to generate all the room designs for the FM system. These two projects are approximately the same size, but the museum is much more varied, while the laboratory has a lot of repetition - and we expect to be able to optimize even more in the future. With IFC, it doesn't matter to us if the project is created in Revit, Archicad or a completely different third system. We have discussed whether we should activate our CAD specification¹² for Space Management data already at the completion of the main project, as we, already at this point in

time, need area calculations to calculate rent, insurance and room allocation in the organization. In the long term it would be good to set the same requirements for the BIM models."

IFC is a gift for Facilities Management

IFC has been an eye-opener for Johs Konnerup Schultz. "If one understands how to navigate the very large BIM projects there is an enormous amount of value in using BIM - even if you only need area data, for example if the room objects contain information about the function of the room. In closed proprietary formats like Revit, Archicad or Vectorworks everything is accessible, but it can be difficult to get data from the programs and convert it for other programs or, for example, for our operations system. With IFC, I have seen the possibilities of working with data. You do, however, have to work a little with the IFC files to get readable designs out of it," Johs Konnerup Schultz explains. "Even if the architect delivered the Museum of Natural History project as Archicad files, it would still be easier for us to use IFC to generate polylines to DWG, as we would control the harvesting of data in two rounds, first when we import the IFC to Archicad, and then when we export the DWG file. It has been quite a steep learning curve to get the new workflow established, but it is definitely something that will pay off in the long term," Johs Konnerup Schultz concludes. Together with his colleagues he has gotten valuable input concerning how KU in the future can set even more precise ICT requirements that creates value for the operations at the oldest university in Denmark.

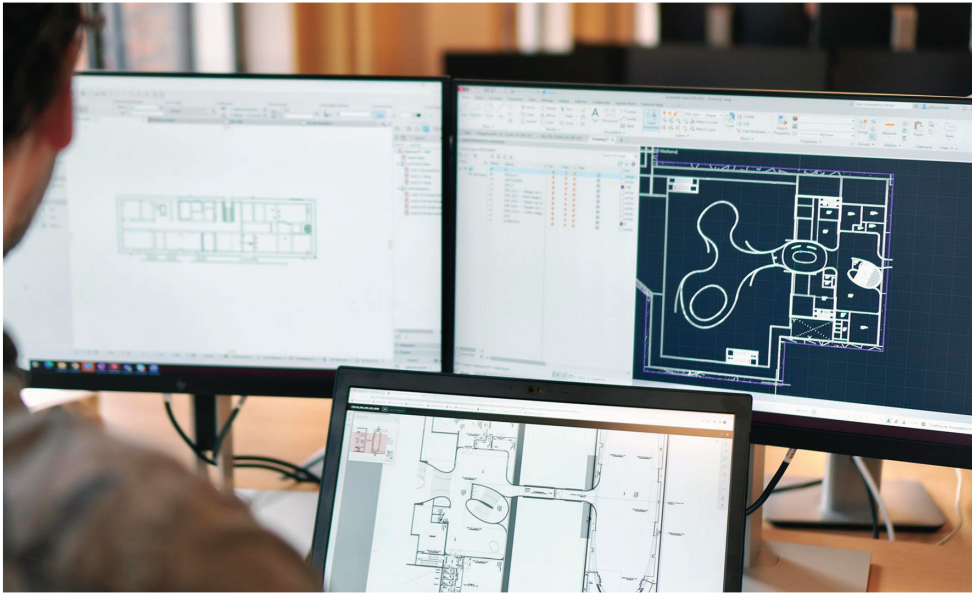
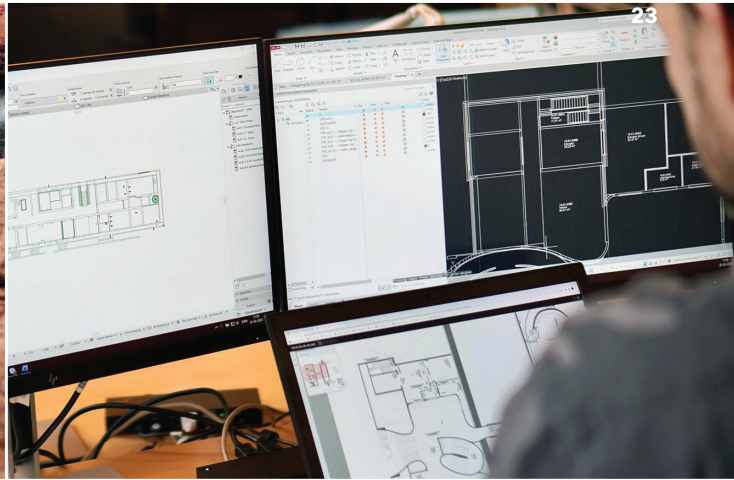
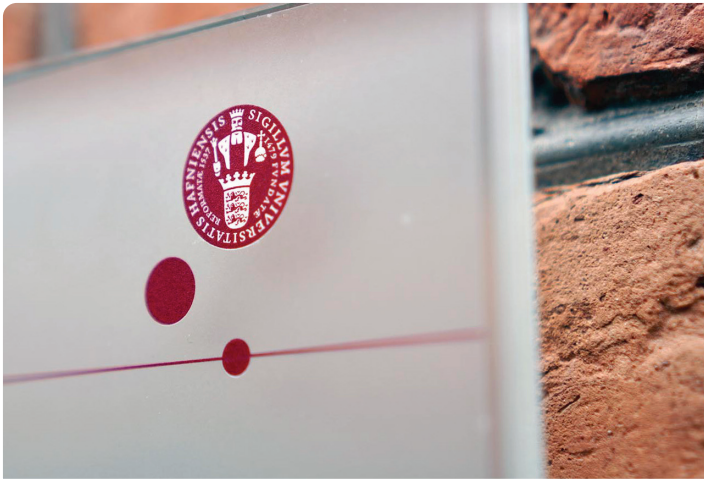
⁸ Polylines are line objects that consist of one or more line segments between a series of points

⁹ DWG is a file format that is used to save and exchange primarily 2D data between different programs

¹⁰ Archicad: Archicad is a BIM program

¹¹ Autocad block is a collection of different objects that as one object can be distributed and updated multiple times

¹² CAD specification is a document that specifies how digital design should be structured



5 Digital collaboration in practice

For you, as the client, to reap the benefits of digital collaboration it is important that you don't hesitate to follow-up on whether you are receiving the agreed upon ICT services on time and in the correct format and structure.

It is important to remember the ICT service is a service on the same level as other services provided for a project, no matter if it is provided by a consultant or contractor. Therefore the same requirements apply for the ICT service as with other services: it should be executed in accordance with the contract, good consultancy and professional practices, and be in accordance with the client's instructions, as it is outlined in ABR 18 § 9, sec. 1, AB 18 § 12, sec. 1 and ABT 18 § 12, sec. 1. And if the service is not provided in accordance with ABR 18 § 9, AB 18 § 12 and ABT 18 § 12, it constitutes a defect service, see ABR 18 § 42, AB 18 § 47, sec. 1 and ABT 18 § 45, sec. 1, and this you should remember to give notice on.

Hesitation with regards to ICT services can sometimes be attributed to it being difficult to understand what the individual ICT service entails and what the consequences or loss of value occur if it is not adequately provided.

Therefore, it is initially important that you as the client try to understand the details of the requirements in the ICT-specification as well as possible before you set the requirements. Furthermore, it is always smart to start a dialogue with the party that is providing the services, possibly accompanied by the consultant to the client, if there is something within the services you don't understand.

If you, as the client, explain why you are setting certain requirements for services, methods, formats etc., it will, to a greater extent, motivate consultants and contractors to provide these services and with satisfactory quality. It could also increase the quality if you explain how the provided service is to be used through different phases of the project and subsequent operation, and how you will check the deliveries of information and carry out sample checks.

You should, from the beginning, specify what consequences it will have - for example for the payment of fees - if the services aren't provided, aren't provided on time or/and aren't provided in acceptable quality. Just defining these factors before consultants and contractors begin their work will often result in better collaboration and higher quality of services.

If the agreed upon service is not provided you should give notice as quickly as possible - preferably through written notice.

If there in the ICT- specification is set requirements for providing digital building models in an open IFC format, but the consultant delivers the model in a software specific model instead, it could mean that, although the client might be able to open the files, they will be ineligible to share with others - for example in relation to subsequent operations or future renovations. Even if the main service (which is the model) is delivered, the collective service is not acceptable, which the client should give written notice of.





6 buildingSMART Denmark

buildingSMART International's openBIM tools and standards contribute to ensuring an open data structure for free dataflow through the entire process of construction. The following openBIM tools and standards from buildingSMART International would be relevant to incorporate for you as client:

- **INDUSTRY FOUNDATION CLASSES (IFC)** is an open data structure for exchange of BIM models that can be used by all common BIM software programs for the exchange of models.
- **INFORMATION DELIVERY SPECIFICATION (IDS)** specifies requirements for properties, materials, degree of detail and specific classifications in BIM models that can be provided in IFC format. The IDS can be understood by a computer and therefore helps both the users and software tools to map, generate, validate and correct data for the desired output.
- **USE CASE MANAGEMENT (UCM)** describes commercial needs and ideal scenarios - including goals and criteria of success - for exchange of information, just like different parties and their responsibilities are specified with actors and roles. UCM follows a uniform structure and is described consistently through all phases of the projects life cycle.

January 1st, 2020 buildingSMART Denmark became established as an independent chapter in buildingSMART International as a subsidiary to Molio. Molio and buildingSMART Denmark participate in work pertaining to openBIM in part to ensure tools and paradigms for the future, and in part to support collaborators as best as possible in their use of openBIM in practice, as well as contribute to Danish practice and insight, thereby contributing to the development of frameworks for business' work and value creation.

buildingSMART Denmark continually publishes guides and other publications that assist the industry in using the buildingSMART tools. See links at the end of this guide.

Molt Wengel Law Firm

Molt Wengel is the country's largest and most specialized construction law office and is a strategic partner to buildingSMART Denmark. We are approximately 80 employees that practice our area of expertise to the fullest extent, and we work with a large variety of actors and specialists in the construction industry. That we understand our client's reality and business is what makes us strategically strong consultants for our clients - and it is what makes it possible for us to reach our ambitions within areas of sustainability, digitization and collaboration.

Specifically concerning digitization, we provide special attention to help our clients on the right path with increased digitization and sustainability on construction projects, because we believe those two things go hand-in-hand. Simultaneously, we work toward making a noticeable difference in the construction industry through, among others, our strategic partnership with buildingSMART Denmark.





Links and references

ICT regulation 118 (public construction):

ICT regulation 119 (public housing projects):

Danish Building and Property Agency:

Molio's manuals/publications (some require subscriptions):

Bygnings Section Specification from Molio/Dikon/BIM7AA:

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