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Technical Report 2017-05
Utilising BIM for NRAs

April 2017

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Executive summary

The purpose of this report is to inform National Road Authorities (NRAs) and other interested parties about the results of the Task group in this field.

BIM stands for Building Information Model(ling) for buildings and includes infrastructure assets. It has already been successfully used, embedded in car and aircraft industry. "Building Information Modelling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle." [1]

For NRAs BIM means focusing on Building Information Management. The main goal is to digitally procure asset data[2] using open BIM standards. Furthermore, an additional goal is to enhance the possibilities of the client in handling data and improving the quality of data in the lifecycle of assets.

The focus of CEDR's Task group S3 (Information) is on the information of constructing, developing and maintaining of infrastructure for roads (and their surrounding areas). Open BIM consists of open information in the structured data sets, open exchange standards and software to use them (BIM tools). An important aspect is the *open* character. Open standards are needed to avoid the risk of the so-called vendor-locked-in.

The goals set for S3 Task group Information were:
+ Sharing knowledge about open BIM; building a sustainable International (social and knowledge) community
+ (More effective) influence on EC decision making regarding development, maintenance and use of Open BIM Information standards
+ Shared investments in the development and use of open BIM standards to a larger extent

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The benefits of BIM are vast: more efficiency resulting in lower costs, better information during the lifecycle of the infrastructure and higher quality. It concerns both new investment projects and asset management. It improves performance of the industry of the built environment as a whole.

To achieve the benefits of the use of BIM it is important to choose a stepwise approach procuring BIM. NRAs have to make sure the steps they choose are coordinated within and outside the organisation in the Construction sector. There are many good experiences in the different NRAs how to start and procure BIM effectively in large infrastructure projects (see paragraph 2.5). Within the Task group three different approaches to introduce BIM in NRAs were recognised:
a.   BIM-approach in an alliance with the private construction sector
b.   BIM approach on information delivery for and during asset management
c.   Governmental BIM-policy for the supply chain.

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[1] Source: National Building Information Model Standard Project Committee (USA).
[2] Asset data means all basis data regarding the physical objects like geotechnical soundings, maps, topography, drawings, traffic data etc. used for asset management and planning. This could include data that someone else owns and maintains.

The CEDR Task group was involved in the UK-governmental initiative to connect with the EC on BIM, which resulted in an interesting working program of BIM for public clients including all NRAs, with support from the EC (EU BIM Task group). The involvement of 13 different EU countries show that BIM and ICT-procurement will be essential for NRAs in the coming years. This was highlighted in the publication of a CEDR BIM leaflet and an article on cost and benefits of BIM in the EU Magazine Pan European networks (Annex V of this report).

The outputs of European BIM projects (like V-con) and BSI-projects (like IFC-Alignment) were reviewed by CEDR.

A CEDR Transnational Research Call was launched in 2015 on "Asset Information using BIM". This was funded by six CEDR-members and will be executed as a follow-up of this Task group in the period 2016-2018. Through the management of the 2015 Research programme, the CEDR BIM network will continue sharing knowledge and experiences of implementing BIM in NRAs. The outcomes of this work will be highlighted at a dedicated BIM Workshop to be organised at the TRA2018 event in Vienna.

The initial goals of the task group S3 have been achieved. It has been proven that collaboration between NRAs on the topic of BIM has been very beneficial content- and financial wise. Examples of this cooperation include the aforementioned co-financing of CEDR Research call, exchange of information with the European Commission and Building Smart initiatives.

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1. Definition of the issue

1.1 Purpose

The Task group S3 Information focuses on a Strategy for the introduction and specification of Building Information Modelling (or Building Information Management; i.e. BIM) at CEDR's National Road Authorities. It is important to find the Common Principles for the introduction of BIM at the NRAs and the common market's construction sector.

A number of the North- and North-Western European NRAs have started, or are now beginning to investigate the use of BIM. The first results show that the benefits of BIM are promising in order to reduce public costs and reduce information loss at your NRA. Important factors for the introduction of BIM are adequate procurement, a consistent, coordinated approach of information delivery and the use of Open BIM-standards. Furthermore the cooperation between NRAs and the private Construction sector in this field is essential.

This report is a result of the Task group S3 on Information of the CEDR Strategic plan 2014-2017 and their work is guided by the CEDR-Technical Group.

About the issue

Adequate information management is of vital importance for the road owner. Based on the information about his network, the road owner is able to take the right decisions at the right time in order to minimize the costs of operation, maintenance and construction and to realize maximum performance of the infrastructure networks. Data transfer from one organization to another, or one process to another, happens all the time; it is time consuming and vulnerable for loss of information and mistakes. Hence, there is a need for new standards for information and for information exchange. These standards should be both at data level and at process level.

The open BIM technology makes it possible to control and transport all the information from process to process, from phase to phase (even during its complete lifecycle), and from organization to organization in a very efficient way. It is becoming more and more important because NRAs are working in an international market. BIM will be one of the most important drivers for transition in the Construction sector. Constructing companies work at a European level. As a prerequisite, Infrastructure objects should use uniform definitions descriptions (one language) one unique classification scheme and subject to digitized procurement. To date, these BIM standards are developed at national and international level. However, synchronization of this development at a European level is needed.

About Open BIM

The focus in this work program will naturally be on the information of building, developing and maintaining of infrastructure for roads (and their surrounding areas). Open BIM consists of open information exchange standards and software to use them (BIM tools). An important aspect is the *open* character. Open standards are needed to avoid the risk of the so called vendor-locked-in. This means that by using an open standard the client creates an open market where data exchange is possible irrespective of systems used by contractors or clients. It also means the standard which is sustainable for the future. NRAs are part of a network, and, as a consequence, need to deliver information to other stakeholders. Obviously, these stakeholders will be in a different stage of the implementation of BIM and its standards.

1.2. Scope

The Task group focuses on Open BIM standards. The aim is not on the development of BIM tools. We expect that the market will develop this once the standards are mature enough. The scope is on the technical aspects of Open BIM standards as well as the more soft aspects like: processes, people & culture, and management & organisation. These are relevant aspects to create added value with BIM (Succar, 2013). Special attention will be given to procurement, use of open BIM standards and libraries.

1.3 Vision

The Digital Agenda of Europe stated that in the virtual world barriers against the internal market are rising, mainly due to interoperability issues. The EU aims for open ICT systems by making better use of open standards in public procurement in order to avoid lock-in[2] and create a European level playing field.

The vision and goals of CEDR Task group Information

The vision of our Task group is to lower the total cost of ownership by creating a European level playing field via open BIM standards for the road infrastructure sector, through shared investments in the development and use of open BIM standards.

The benefits of BIM are: better information during the lifecycle of the infrastructure, higher quality and sustainability of the infrastructure, more transparency (better accountability to the political level), increased productivity and faster delivery and more innovative and competitive European industry.

To realize this vision CEDR S3 formulated four long term objectives (2020) to stimulate and give direction to
1) the development of European Open BIM Standard on semantics
2) the development of European Open BIM Standard on data
3) the development of European Open BIM Standard on process
4) the development of a governance structure for the maintenance of the European Open BIM Standards.

Underlying goals for S3 are:
• Shared investments in the development and use of open BIM standards to a larger extent
• Sharing knowledge about open BIM; building a sustainable International (social and knowledge) community
• (More effective) influence on EC decision-making, regarding development, maintenance and use of Open BIM Information standards.

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[2] See http://ec.europa.eu/digital-agenda/en/open-standards.

1.4. Methodology

The Task group used the following methodology:

- Knowledge exchange: presentations during each meeting of the Task Group S3.
  This is a very efficient way to exchange information and learn from each other.
- Inventory of current BIM practices.
  The inventory is limited to the CEDR countries of Task group S3, because it is quite difficult to find the right information and compare it in a suitable way. The inventory was partly done through gathering (financial) information at the NRAs and partly through a maturity scan (self-scan via internet) developed by research institute TNO in the Netherlands.
- Influence, mainly on a personal basis through formal and informal BIM networks.
- Involvement in European initiatives (EU-BIM-taskforce) and EU-calls.
- Questionnaire.
  For the subject procurement a web based questionnaire was developed and executed in order to gather specific BIM approaches within the S3 countries. This was the most efficient way to reach out to colleagues.

2. Results on BIM

2.1. What is BIM and BIM Maturity

BIM stands for Building Information Model(ling) or Building Information Management and is used in car industries, buildings and can also be used for Infrastructure. "Building Information Modelling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle." Source: National Building Information Model Standard Project Committee (USA).

For NRAs, BIM means focusing on Building Information Management. The main goal is to digitally procure asset data using open BIM standards. Furthermore, the objective is also to enhance the possibilities of the client in handling data in the lifecycle of assets.

On a global scale, two well-known international arrangements to categorize Open BIM Standards are available.

Firstly, the Building Smart organisation developed the information interoperability triangle (Figure 1), which is used in information science and in other industries. There are three types of open BIM standards: terms, data and processes.
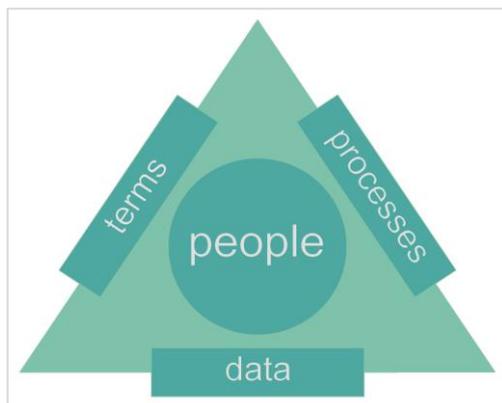

Figure 1: Interoperability Triangle Building Smart

Secondly, the UK BIM Task group developed the *BIM maturity model*[3] (Figure 2), that is increasingly being used within Europe.

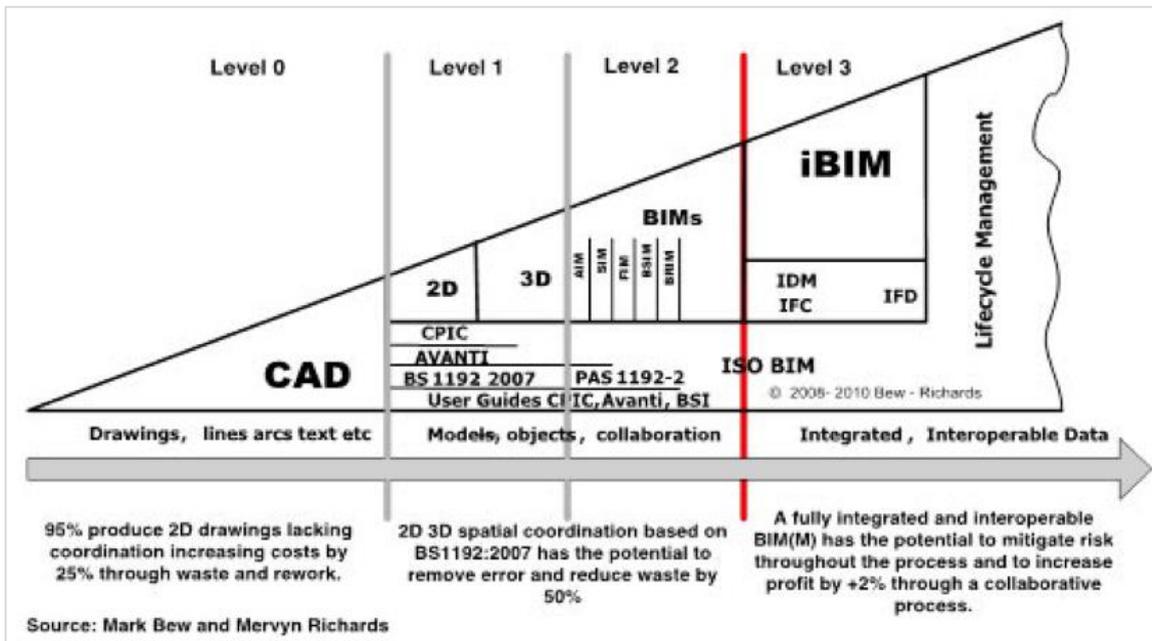[3] Published in PAS1192.2. See http://www.bimTask group.org/pas11922-overview

Figure 2: BIM Maturity model (UK BIM Taskforce)

A short explanation of the levels:
- Level 0 - Unmanaged CAD typically 2D, with paper (or 'electronic ink') exchange between participants.
- Level 1 - Managed CAD in 2D or 3D using a special standard with a common data environment, but stand-alone commercial data management
- Level 2 - Managed 3D environment using separate discipline "BIM" tools with attached data and integrating commercial data
- Level 3 - iBIM or integrated BIM potentially accessing all available data forms, adding value in operation and supported by open standards.

2.2 BIM inventory and benefits and risks of BIM usage for NRAs

Inventory
The goal of the inventory was to achieve insight in the approach and investments in BIM and the returns of these investments as well as to illustrate the value of BIM. With this inventory the Task group wants to encourage:
- Other countries to use the open BIM standards.
- Software vendors to be aware of open BIM standards to implement in their software.
- NRAs to exchange knowledge and information for further implementing BIM.
- The EC to underpin the relevance of a sustainable governance structure for open BIM standards.

The result of the investigation can be found in Annex I. The main conclusions:
- There are different BIM approaches, some of them starting bottom-up from a technology push and some of them starting more top-down from a strategy pull, or a combination of both. There are also differences between the different countries because of:
  - Policy setting
  - Maturity of BIM development
  - Current efficiency in dealing with information
  - Effectiveness of BIM implementation in project practice
  - Chain connection in the sector as a whole.
- From the maturity scan in general, we see that section management and organization has relatively high score and the section technology and applications seems to lack behind. Overall, the aspects are reasonably in balance.
  A small number of aspects have a lower score: tools, mentality and education (Figure 3). This corresponds to the barriers for BIM adoption as found in literature (NBS report 2013).

Figure 3: Blended results of the maturity scan on aspects of the six countries

- The European CEDR countries invested about 59,6 M Euro in BIM development programs for the period 2007-2017
- BIM implementation projects at NRAs are delivered in open BIM (often created in closed BIM in the supply chain) and mostly at design & construct level.

- The BIM implementation projects in the different countries show that there is a real market for (open) BIM technology.
- Based on the amount in the portfolio 2014, the estimated combined structural cost savings for design and construct for The Netherlands, Sweden, Finland and Norway is about 378 M Euro per year as of 2020 onwards (ca. 8,2%).
- The total cost savings, also taking into account the order portfolio for maintenance, will be even higher. A stronger connection to asset management is important because BIM is the key to their business, so the awareness has to grow.
- There is a very high ROI: investment in BIM programs versus cost savings.
- A sustainable governance structure for open BIM standards is important, in order to realize cost savings and to implement the EU policy on open BIM standards in an effective way.
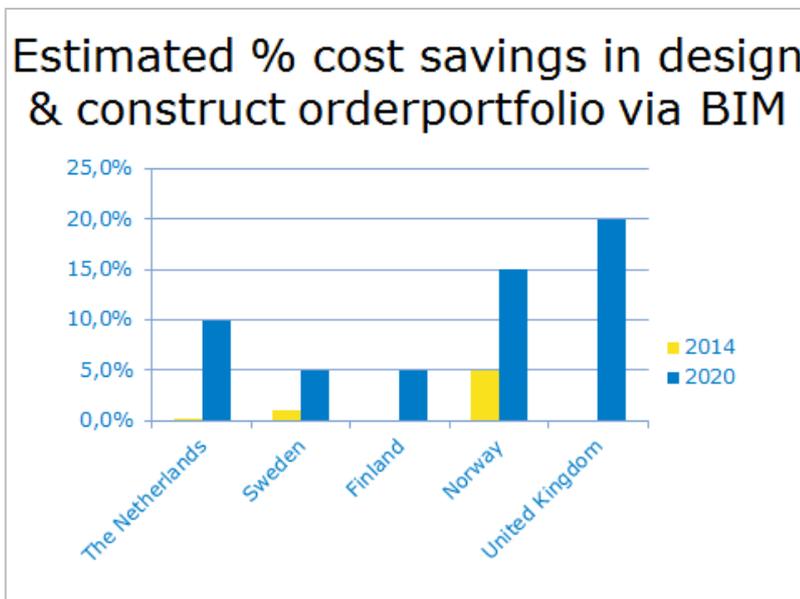
Figure 4: Estimated percentage cost savings design & construct in 2014 and 2020

The estimated percentage cost savings in 2014 for design & construct varies between 0,1 and 5 %, because BIM is still being used in a limited way or on a pilot basis. The estimated yearly cost savings percentage for 2020 varies between 5 and 20% (on average 8,2 %). This percentage can grow even further, for example the estimation of the UK government is 30% in 2025.

Benefits of BIM for Public Clients
Implementation of BIM in the construction sector will also benefit Public Building, Road and Rail authorities. The results of the inventory shows that savings can be up to 30% of the building/construction costs. Figure 5 shows that information loss during construction phases can be limited by using BIM and thus also the related failure and communication costs. For Public Clients good asset information is also essential for better life cycle management.
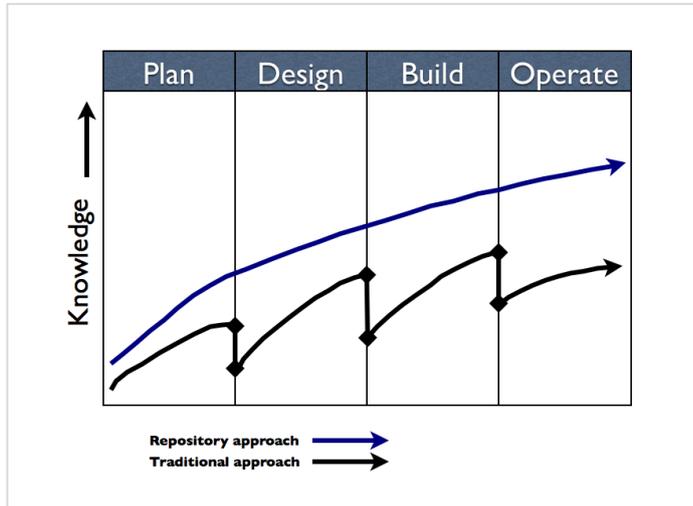
Figure 5: Current loss of information and failure costs, to be solved by using BIM

The main benefits of BIM are:
- Reduction of failure costs and transaction costs.
- Better communication with the stakeholders.
- A solid information base for asset management and life cycle management.
- More transparency and better accountability on a political level.
- Clear procurement and efficient working processes leading to better quality.

Benefits from the UK Government Cabinet Office BIM Strategy Paper are visualized in Figure 6.

Figure 6: Benefits UK Government Cabinet Office BIM Strategy

Risks of using BIM

Some risks may occur if you setup and use BIM. Embedding BIM at your governmental institute has to be done step by step. Furthermore, the available BIM technology needs to be clearly understood in order to apply these appropriately in the specific phase of the construction process. For instance, 3D models are often identified as BIM and vice versa. In our practice, that is not what we mean with BIM. Recall that BIM means Building Information Management. BIM, therefore, aims to control information in the whole value chain. BIM 3D models are especially useful in the design phase. It is obvious though 3D models require the right asset Information.

Furthermore, it is important to realize that two caveats may potentially limit your expectations:
- BIM-models tend to become big. Hence, you need to make sure what kind of information you really need in the maintenance phase (maintenance-parts of the construction) in order to limit the amount of asset data you receive.
- The naming of objects and their corresponding properties in 3D BIM models may differ from the naming of the objects in asset management systems.

As a consequence, this BIM generated information might be not be fully useful for the asset manager. Furthermore, all digital models have to be maintained. This could imply high maintenance costs as well as the need for specific applications, databases and knowledge with regard to asset management. Construction parties very often use different applications and databases for their BIM-models they often have The Task group recommends to implement standard ways of working regarding information exchange for the whole information chain. Otherwise the risk exist that you encounter extra costs due to the use of different information standards. Information loss during the construction phase and later are often extra costs for asset owners.

2.3. How to use BIM

To reap the benefits of using BIM such as better quality, at lower costs and no information loss, you have to choose a stepwise approach. As an NRA, you have to make sure the steps you choose are coordinated within and outside your organization in the construction market.
Some best practices when starting BIM are:
- Check your ICT-status; digitizing formats, use of standards, uniformity in asset management, use of databases and level of BIM maturity.
- Processes first, BIM later; optimize procurement, asset management, information delivery and start using BIM later at your NRA and constructors.
- Focus on Life Cycle of Asset Information; formulate the information you need during exploitation and AM-phases.
- Focus on planning of Construction; ask for visualization and BIM-use in the planning and design phase and stimulate BIM-use in construction.
- Use technical standards; ISO-standards, IFC, IFD, OGC (GIS) and CEN-standards
- Use object type libraries; libraries structure objects, their functions, their demands and your information needs.
- Ask specific data from BIM-models; Models often contain irrelevant information, so focus on information relevant for AM and for making client decisions.
- Structure and validate data before you accept it and pay for it.

Within the Task group S3, three different approaches to introduce BIM at your NRA are recognized.

a.   BIM approach in an alliance with the private construction sector
Often NRAs have organized BIM together with constructors, designers, engineers and universities in a BIM alliance. This alliance develops and implements BIM in large projects. It is a good way to start with BIM in cooperation with all specialists in the construction chain. Examples of this approach can be found in Finland, France and Sweden.

b.   BIM approach on information delivery for and during asset management
An NRA can choose to make an Information Delivery in the contracts of projects and influence the structure and databases inside and at market parties, in order to ensure standardization and use of Open BIM standards. Those standards such as IFC, IFD, IDM, COINS, etc. assist object related communication and data-exchange (see figure 7). An example of this approach can be found in the Netherlands.
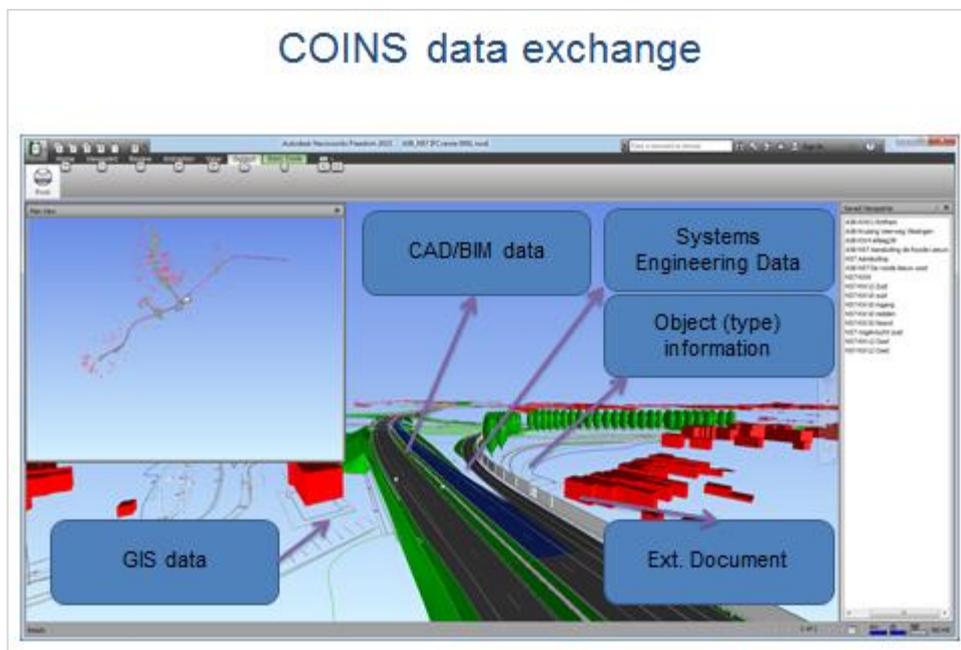
Figure 7: Open BIM-standard COINS for advanced data exchange

c.   Governmental BIM-policy for supply chain

A good governmental policy for the supply chain with focus on the use of uniform processes, uniform BIM-models and focus on information for decision making and asset-management is the most mature and severe approach. Governments lead and guide the BIM implementation within their institute and push BIM use in the construction projects.

Examples can be found in United Kingdom and Norway.

Figure 8. Road construction and accompanied BIM-model of same road in Trondheim (Norway)

2.4. EU-initiative on BIM

In 2014, a UK-governmental initiative was taken that same year to connect the EC with BIM. The chair of the Task group S3 was involved in this initiative. It resulted in a working program (Annex II) with BIM for public clients and support from the EC. The involvement of 13 different EU-countries on this BIM-topic shows that BIM and ICT-procurement will be essential for all NRAs in the coming years.

2.5. Procurement of BIM

In several phases of a project the Task group members used different approaches and therefore also different ways of procuring BIM. Procuring BIM in a step-wise-approach in a large construction project is the best way to learn and improve your knowledge and experience with BIM. This report doesn't take into account the procurement of maintenance projects. Today, the most experienced NRAs operate with data on both open standards and proprietary formats.
A web based questionnaire was prepared in order to find specific important points of procurement of BIM. Below a number of key findings are presented. The complete results are can be found in Annex VI.

Key approaches that are important when procuring BIM:
- Describe the structure of the data that is to be exchanged
- Specify that data has to be delivered on open standards as far as possible.
- The specifications (level of detail) varies with the type of contract (for instance between a Design contract or a Private Public Partnership contract)
- If you want to use BIM-models at your NRA, specify the purpose of these models. These purposes are, for example, for presentations in meetings with decision makers and the public, for making presentations/animations/simulations, to produce data for machine guidance and set-out data in construction phase, to produce MOM-data
- Define standardized categories of data/information that is to be procured (deliverables)
- Focus on the life cycle of asset information; formulate information you need during exploitation and asset management phases.
- Ask for information obliged by other legacy systems outside NRAs.
- Specify quality measures and quality control methods that the parties have to use when producing the digital information and when exchanging information (how, when, which format)
- Decide on the quality approval methods, time frames, how to handle revisions, errors and changes
- Define roles and responsibilities for handling digital information.
- Technical specification regarding deliverables should be formally documented and used as a reference in contracts/tender documents
- Given the fact the certain type of contract (i.e. Design and Built DB, Design, Built and Maintained DBM and Design, Built, Financed and Maintained DBFM/PPP Contracts) have more resources available, it is advised to start procuring BIM in these Integrated Contracts/Projects .

Some general conclusions could be drawn regarding procurement of BIM
- All the CEDR S3 countries are in transition from using analog to digital information

- Standardization on object level is a key factor for this transition
- The information has to be organised on open, standardized formats
- There is a need for standardized libraries of information objects
- There is a strong need for digital asset information and digital exchange of asset information
- There is a strong need for uniform digital information describing the existing situation: e.g. survey-data (terrain models), existing water and sewage installations, electrical/signal cables, existing infrastructure/constructions;
- There is a strong need to share information between legacy systems on national and international level
- NRAs play a major role in stimulating the entire construction chain by procuring BIM and therefore achieving benefits for the whole industry;
- Digital asset information delivery (what, asset data, how, using open BIM-standards, and when, frequently delivered and validated) should always be part of all infrastructure contracts at NRAs.

The maturity of general procurement at your NRA (see results CEDR S6 group), should be a guideline when you start and for the approach of procuring BIM. You can reach out to the members of this Task group for assistance.
The CEDR S3 countries have experience in different contract/procurement types and different levels of detail in specifications/documents.

2.6. Proposals BIM libraries

In line of the work of Building Smart, open BIM standards are concerned with terms, processes and data (Figure 1). Data and terms can easily be structured using a BIM object library. These physical objects are part of the infrastructure network NRAs develop and maintain. In several EU-countries BIM-dictionaries and libraries are being developed at this moment.

In august 2014, the Task group prepared and submitted a proposal for European subsidy for the EU-call Horizon 2020 (Annex IV). The subject of the proposal was to establish a European network, which sets the requirements for a European object library. The consortium consisted of two national road authorities (NL and S), Egis (lead beneficiary), BAST, a Portuguese university and Portuguese network of construction companies, CSTB, TNO and the University of Eindhoven, Catenda, Swedish Building Center and BRE (UK).
Unfortunately the proposal was rejected in January 2015.

This idea was adopted and resulted in preparing a similar research proposal for a European Library as a CEDR-call 2015 entitled "Asset Information Using BIM" (Annex IV). The proposal was discussed with NRA Asset Management specialists (N2). Funding was found at 6 NRAs and research proposals were received and selected. In the summer of 2016 the consortium Interlink was contracted to execute the research the coming 2 years. The NRA-funders are guiding the research as a so called Program Executive Board (PEB).

2.7. Miscellaneous

The Task group also decided to follow interesting EU-projects and Building Smart projects concerning BIM. Below you will find some results of these projects.

V-Con is a European project co-financed by the EC and carried out by Rijkswaterstaat, Trafikverket, TNO and CSTB. This project runs from 1 October 2012 to April 2017. The aim of this project is to put a tender on the market asking the IT sector to develop innovative IT solutions based on open BIM standards and capable of working with object type libraries. The tender was published on March 22nd 2015 and closed after 6 weeks. Before the summer of 2015, 6 consortia were selected to perform the first stage of development starting after the summer holidays. In total 3 stages are carried out and it ended with only two consortia which developed and tested their IT solution. Potentially the results of this project might be of interest to all CEDR members aiming for internal and external interoperability regarding the information of their assets.

In the first two years of V-Con a development was performed of IFC alignment and IFC roads. IFC is an open BIM standard mainly suitable for buildings. Rijkswaterstaat and Trafikverket have invested in the development of IFC alignment as a first step in order to make IFC also applicable for infrastructure. The development of IFC alignment has been carried out and will be incorporated in the next IFC version. OGC, the worldwide network for open geospatial standards, has contributed to this IFC alignment, which secures that alignment can also be incorporated in the OGC standards. CEDR members may benefit from this development since alignment has been modelled in, not only open BIM standards, but also open geospatial standards. This is an important step for CEDR members to be able to be interoperable on the subject of alignment with open standards i.e. in a vendor neutral fashion.

The next interesting work at Building Smart is the Project IFC roads. The project goal is to enhance IFC with all the necessary road elements (objects). Interested CEDR members may invest in this development. An initial development has been carried out by the V-Con project.

3. Conclusions

The purpose of this BIM report S3 on Information was to inform the CEDR Boards about the results of the Task group undertaken during Strategic Plan 3 (2013-2017). Members of that Task group will continue their work and involvement in BIM at NRAs and on a European and International level.

Activities will continue through the CEDR-call 2015 PEB meetings to guide the research of the "Asset Information using BIM" and exchange knowledge on implementing BIM. In addition, the BIM-projects from Building Smart International and the EC (e.g. V-con) will continue and NRA-members will stay involved in these developments.

The outcomes of this work will be highlighted at a dedicated BIM Workshop to be organised at the TRA2018 event in Vienna.

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Annex I - BIM Inventory

Introduction

The goal of this inventory is to get insight in the approach and investments in BIM and the returns of these investments, to illustrate the value of BIM. With this inventory, we want to encourage:

- Other countries to use the open BIM standards
- Software vendors to have an eye for open BIM standards to implement in the software
- NRAs to exchange knowledge and information for further implementing BIM
- The EC to underpin the relevance of a sustainable governance structure for open BIM standards.

In the following paragraphs we will give a short introduction to the BIM approach in different CEDR countries, a maturity scan and a financial inventory including some information from literature. Finally there is a conclusion. The inventory is limited to the CEDR countries of Task group S3, because it is quite difficult to find the right information and compare it in a suitable way.

1.1 BIM Approaches

The Netherlands
Rijkswaterstaat (RWS) is a special departmental agency with a budget of 5 billion Euros. RWS manages the following networks: highways, water system and main waterways. The staff has decreased in the last years and more tasks have been taken over by the market. A specialty is working with long-term contracts for design, build, finance and maintain. By giving the market a responsibility in financing and a long-term contract, good deals can be reached.
Since 2012 a large BIM program is going on at RWS. It focuses on: asset information in control en information flow in control. The strategy is to directly test results in the largest road infrastructure projects. The information delivery and professional interactions (process, roles) are described in the contract. Besides that, there is a national BIM Program with involvement of all stakeholders like governments, architects, building companies, consultancy firms and installation sector (Building Information Council). BIM is seen as a motor for the Building sector in the Netherlands. There are 3 types of activities: Information technology (open BIM standards), management and organization and cultural restrains. It takes place in connection with Building Smart International (project IFC alignment and BSdd).

Sweden
Trafikverket is the Swedish Transport Administration for both road and rail administration and is responsible for planning of road traffic, rail traffic, maritime shipping and air traffic.

There are challenges on short, medium and long term. 1) short term: BIM implementation project run successfully, developing skills and knowledge, need for an object library, taking care of feed-back from users and project-managers, evolving the procurement requirements 2) medium term: getting different departments of Trafikverket working with BIM from a common point of view. Efficient implementation of results of EU BIM project V-Con 3) long term: efficient data flow between GIS - Projects using BIM – Asset management systems. On national level Swedish organizations, public and private, work together in the BIM Alliance Sweden (also under Building Smart umbrella). They work together on BIM issues concerning the built environment.

Finland

The Finnish Transport Agency (FTA) is responsible for road, railroad and commercial waterways and is the largest infrastructure-owner in Finland. It is a government agency. The annual budget is around 1.92 billion Euros. Major issues are intelligent register, archives, regulations, competences and starting discussions with other public authorities on the data (ownership, responsibility for keeping up, sharing data with open standards). FTA needs also a clear policy about the information that is needed in our operational level and strategic level.

There was a large R&D projects called InfraFINBM in the years 2010-2014 in Finland. The goal of Infra FINBIM research was to develop and realize a new information modeling and automation based process and model, in which the intelligent and information contents of different models needed can be created, used and utilized throughout the infra construction, maintenance, rehabilitation and maintenance process and work phases.

The key results in InfraFINBIM work package were:
- Draft version of common infrastructure model requirements (guidelines)
- Inframodel open information exchange format
- Infra structures – numbering and naming (classification)

The work continues under buildingSMART Finland. In year 2014 the strategy for vision "2025" was made. Main task for the year 2015 are:
- Upkeep the inframodel 3 and make extensions to it.
- Extends classification
- Participated in standardizations (in buildingSMART international)
- Continue work with common infrastructure model requirements (guidelines).

For more information about progress see website: www.infrabim.fi/en

In 2015 FTA is working with its own BIM strategy together with ict-department and asset management. New developments, which are already in use, are: real time quality control, and the structured data sets for initial data. Main development needs in the near future are register, asset management data, and information scheme through different phases. Other important things are education and communication of all levels. The idea at FTA is not to do only BIM-pilots, but try to implement BIM based ideas especially in design and construction phases.

Norway

The Norwegian Public Roads Administration NPRA is the directorate of public roads and is responsible for the national and county road networks, ferry operations, public transport, vehicle inspection and requirements and driver training and licensing. NPRA has a practical approach and realized a BIM handbook "Basis for models" in 2012. They work with the Virtual Design and Construction (VDC) methodology, which is about integration of models. The VDC methodology enables more effective planning, engineering, building and maintenance. 5% cost reduction can be documented in projects so far, in 2014 (6 projects analyzed). The number of VDC-projects is growing, but it is still up to the project-manager to decide if the handbook methodology is followed; but it will probably be made a standard in future road projects. The Norwegian railway department has made also a handbook for model-based design.

The challenges are: lack of object definitions, lack of model definitions, lack of standardized libraries and lack of complete open source standardized exchange format. Also the level of detail (LoD) is important.

Denmark
The Danish Road Directorate (DRA) constructs, operates and maintains the state road network. The interest of BIM started in the construction. The DRA does not build by itself, all tasks are put out to tender and resolved by the market. There is an ongoing project to increase productivity through the whole construction process, by change in digital design and construction methods. There is a national collaboration: infrastructural owners, Danish Association of contractors and Danish Association of Consulting Engineers with also exchange of data. The contractors started to ask for the 3D Models and now DRA is working with 3D Models in the design phase. The national collaboration works with participation and funding on a voluntary basis. It is a forum to discuss the use and promotion of digital workflows. They work with small projects and development of recommendations (not standards). One of the projects is an object library.

UK
The Highways Agency is responsible for operating maintaining and improving the strategic road network in England. Its road network is around 7000 km, which carries around one third of all traffic by mileage and two thirds of all heavy goods traffic.

The Highways Agency is adopting the UK BIM Government Strategy for the delivery of assets through life cycle information from planning through design, construction and operation. It is supported in implementing this supported by the UK BIM Task group.

The objectives of the strategy accelerate the adoption of BIM throughout the UK construction supply chain.
By creating critical mass and certainty of demand, we will provide the confidence that will enable businesses, training organizations and professional bodies to invest more rapidly in the development of their own capability. Through selective investment in standards and protocols we will reduce adoption costs for the industry. In addition to the direct benefits, which the Government Client will secure through BIM adoption, we expect that project teams will make wider use of enhanced BIM capabilities on behalf of all construction clients.

The strategy is data driven and 'it's all about the data'

There are three key deliverables:
- The individual domain 3D models in their native file formats
- The 2D reviewable design deliverables cut from the models
- COBie UK 2012 data

The Government's view is that BIM is an important enabling element of the wider Construction Strategy. BIM will provide the information foundation for the work of integrated teams – the Government's preferred strategy for project delivery – driving value in, and cost out of the design and construction process. The information provided by the BIM model will be valuable in enabling the Government Client to confirm that facilities meet performance expectations and also in providing a readily accessible source of information for the teams involved in operating, maintaining and adapting completed facilities.

To support this the Highways Agency are developing and implementing standards based on the BIM-task group standards suite including data standards, file naming standards, common data environment standards, common Employers Information Requirements and Asset Information Requirements.

The UK BIM Strategy is based on the following hypothesis:

Government as a client can derive significant improvements in cost, value and carbon performance through the use of open sharable asset information.

The hypothesis is important as it enables the team to demonstrate across a range of performance dimensions that useable benefits will be secured. The tests that we used to confirm benefits cover the following criteria.

Hypothesis Criteria	Description
Valuable	The overall aim is to maximize client value by increasing benefits at little or no extra cost.
Understandable	The approach is to be presented in an understandable learning package suitable for different types of government asset procurers.
Generally Applicable	The approach is equally applicable to buildings and infrastructure, whether large and small new build and where possible existing structures.
Non-proprietary	All requirements are non-proprietary as to applications and as to the required formats of the deliverables.
Competitive	Wherever possible there are at least two solutions or methods available so as to minimize market influence in terms of anti competitive clauses.
Open	Wherever possible, low-cost methods are to be made available to allow all stakeholders to participate, irrespective of size and experience, so as to minimize barriers to involvement.
Verifiable	All contractual expectations are documented with transparent and testable measurement of pass / fail.
Compliant	Measurement of LC/Carbon/Sustainability/etc. is published to GB, EU and ISO standards.
Implementable	The approach is self-funding by the client and the industry

1.2 Maturity scan

In 2009 the "BIM QuickScan" was created in the Netherlands by the Dutch knowledge institute TNO (see also www.bimquickscan.nl). Goal of the BIM QuickScan is to give insight into the strengths (and thereby also the 'weaknesses') of the organization regarding BIM aspects. It consists of an online questionnaire with almost 50 questions in 4 chapters (sections):

1. Organization and management
2. Mentality and culture (people)
3. Information structure and information flow
4. Technology and applications.

Within the first chapter (organization and management), the following KPIs are addressed: vision and strategy, distribution of roles and tasks, organization structure, quality assurance, financial resources and partnership on corporate and project level. The second chapter (mentality and culture) focuses on BIM acceptance among the staff and workers, group and individual motivation, presence and influence of the BIM coordinator, knowledge and skills, knowledge management and training. The following KPIs are composed in the third chapter (information structure and information flow): use of modelling, open ICT standards, object libraries, internal and external information flow, type of data exchange and type of data in each project phase. The hardware- and software-related KPIs are pulled together in the last chapter (technology and applications): use of model server, type and capacity of model server, type of software package, advanced BIM tools, model view definitions and supporting rules.

The scan can be filled in as a self-scan, or with the help of a certified BIM Quick-scan consultant. All questions are multiple choice. After filling out the complete questionnaire, the respondents receive a result that states their level of BIM. Depending on the given answers more or less points can be earned. Not all questions influence the final result in the same amount.

The output of the quick scans is structured in two different ways. The first way of structuring the output, is by using the four categories or sections. The result per category is a score on an open scale. The result of a BIM QuickScan will remain the same in time, but the maximum score may rise in time, since the state of the art of BIM advances. Therefore the potential, or the

performance gap to be bridged, can grow larger in time when the BIM level of a certain organization remains the same. At this moment, for each section the maximum score is 4, except the section Information Structure and information flow (maximum score is 5).The other way of structuring the output is by aspect. All questions in the BIM QuickScan are categorized under at least one aspect. These are not restricted to individual chapters, although some relations between chapters and aspects are unavoidable. The aspects that are distinguished are: Strategic; Organization; Resources; Partners; Mentality; Culture; Education; Information flow; Open standards ;Tools. The score of the aspects is displayed in a radar diagram where each score is displayed as a percentage of the maximum score. This gives an overview of the strong and weak points in the BIM performance of a company.

The scan has been filled in by the CEDR S3 countries for their own organization (NRA) via the self-scan. The goal of the self-scan is to create awareness, the results are two figures per self-scan. The experience of the CEDR S3 countries is that it was quite difficult to perform the scan as a self-scan, so we have to be careful to compare the results. The results of the self-scans are as follows.

The Netherlands
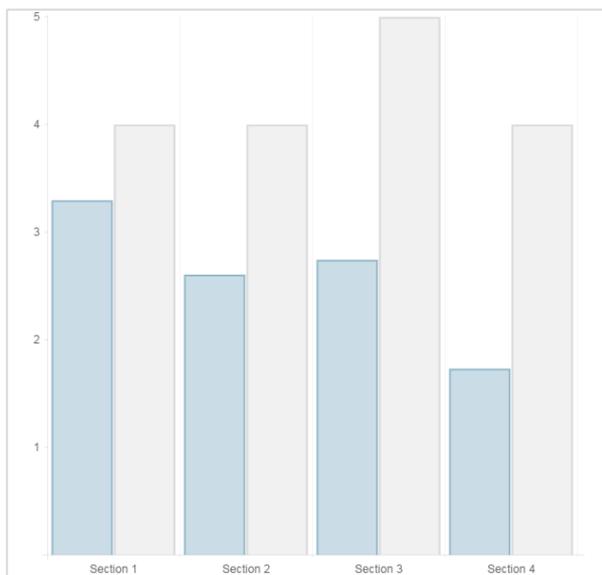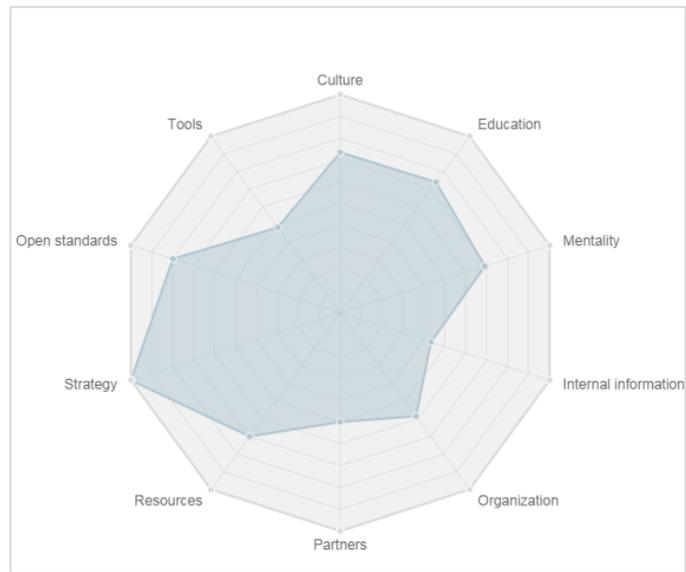
Figure 1: The Netherlands

There is a high score on the section management and organization index, and strategy. Also open standards have a relative high score.

Sweden
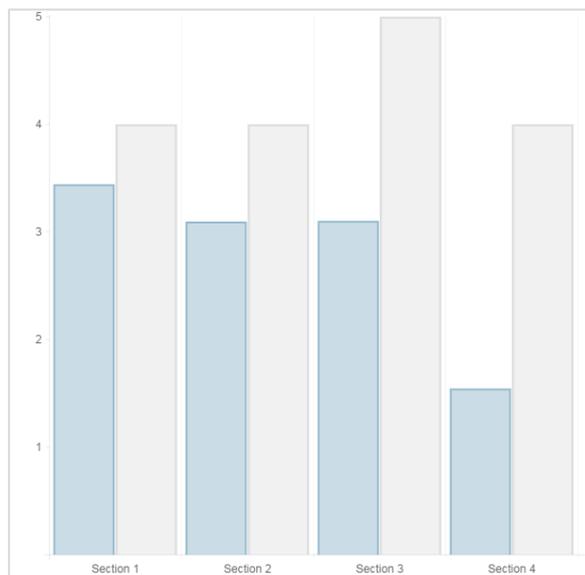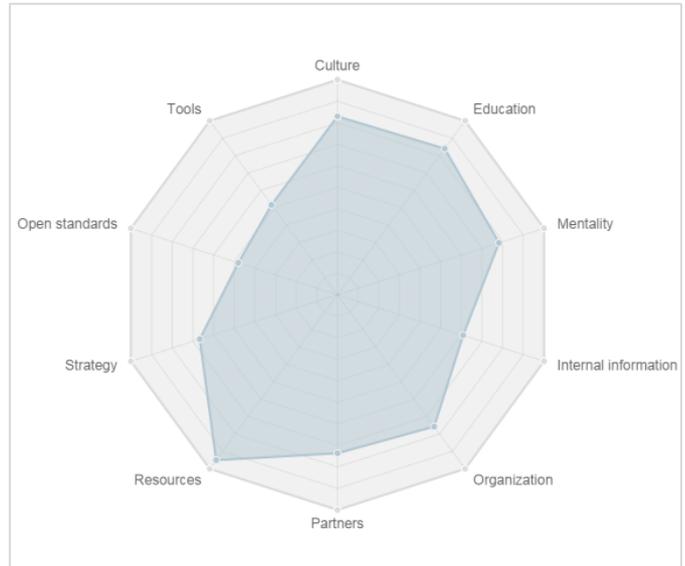
Figure 2: Sweden

The scan of Sweden has a relative high score on the section management and organization index, and on the aspect resources.

Finland
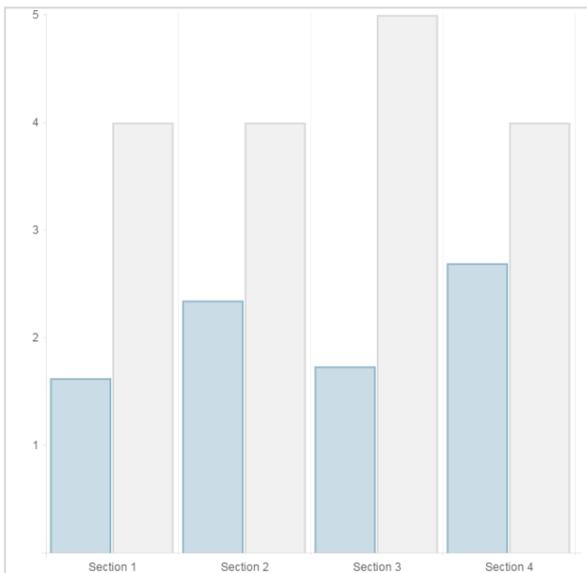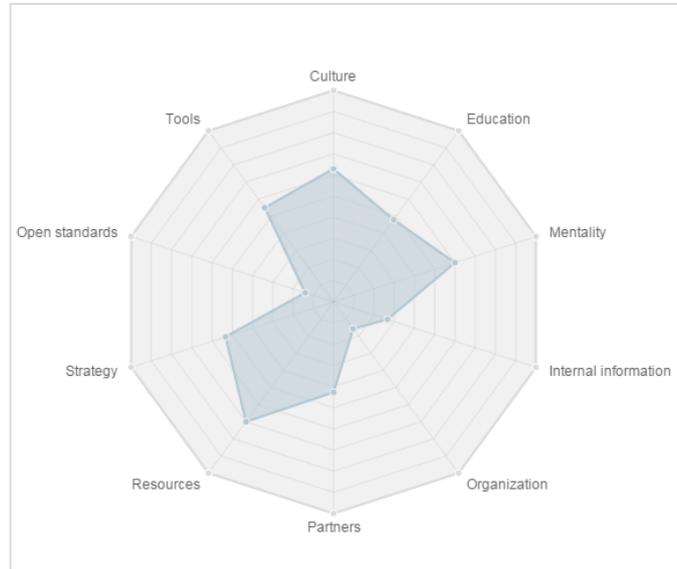
Figure 3: Finland

The scan of Finland has a relative high score on the section Technology and applications, and on the aspects culture and resources.

Norway
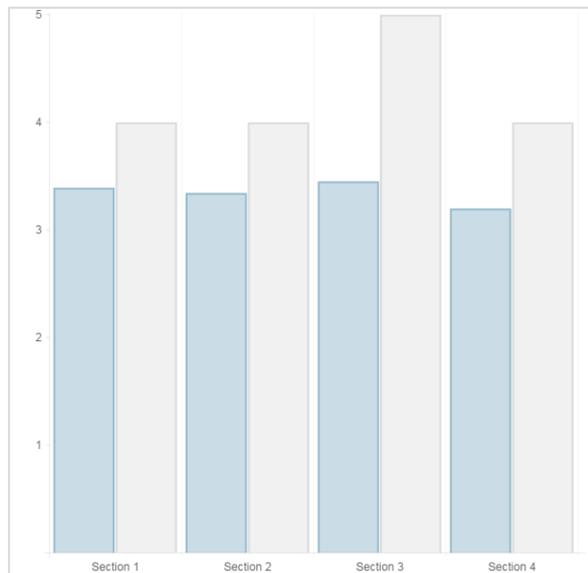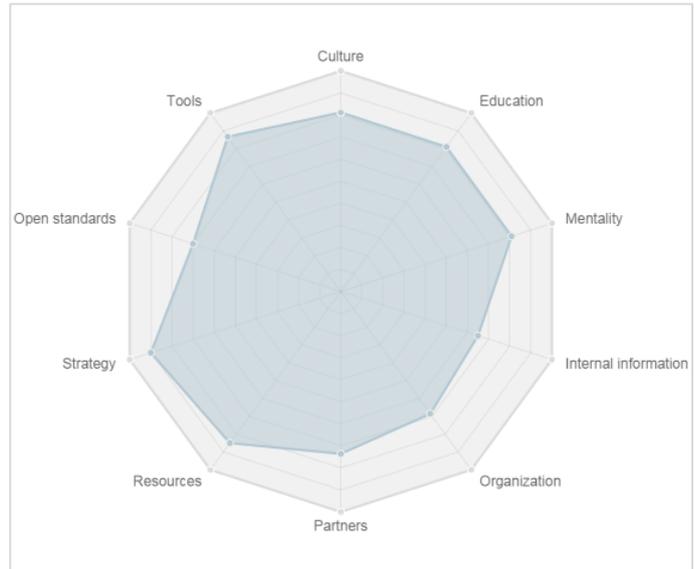
Figure 4: Norway

The scan of Norway shows a quite high score on all sections and themes, which illustrate a steady and balanced approach.

Denmark
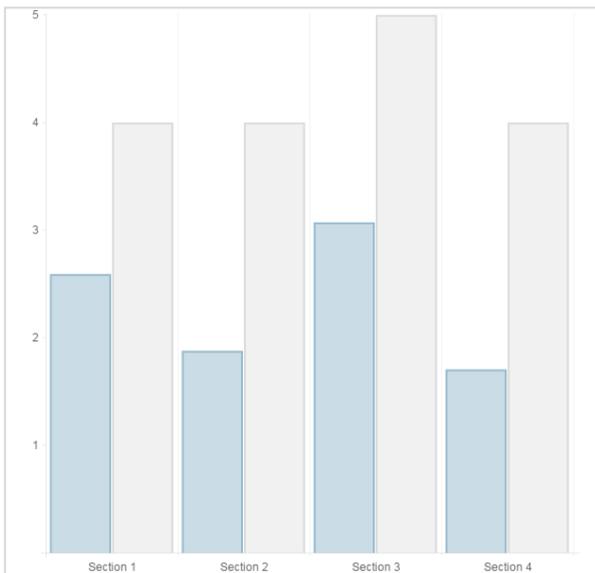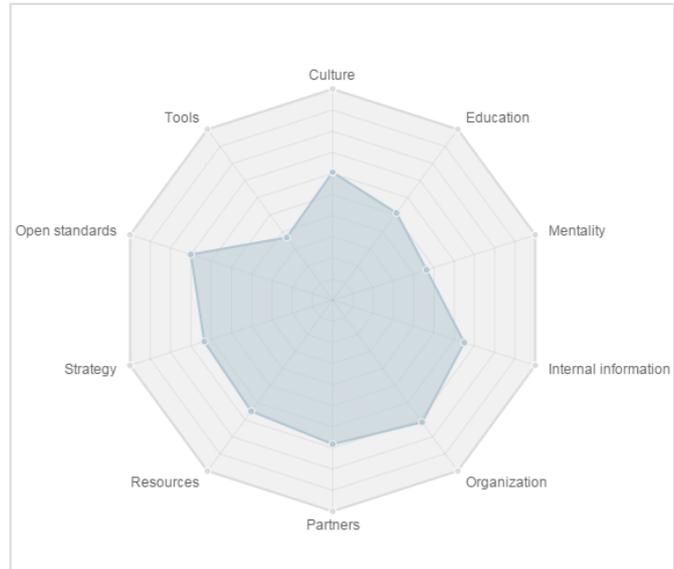
Figure 5: Denmark

The scan of Denmark shows a high score on Information structure and information flows, and the aspects organization and open standards.

United Kingdom
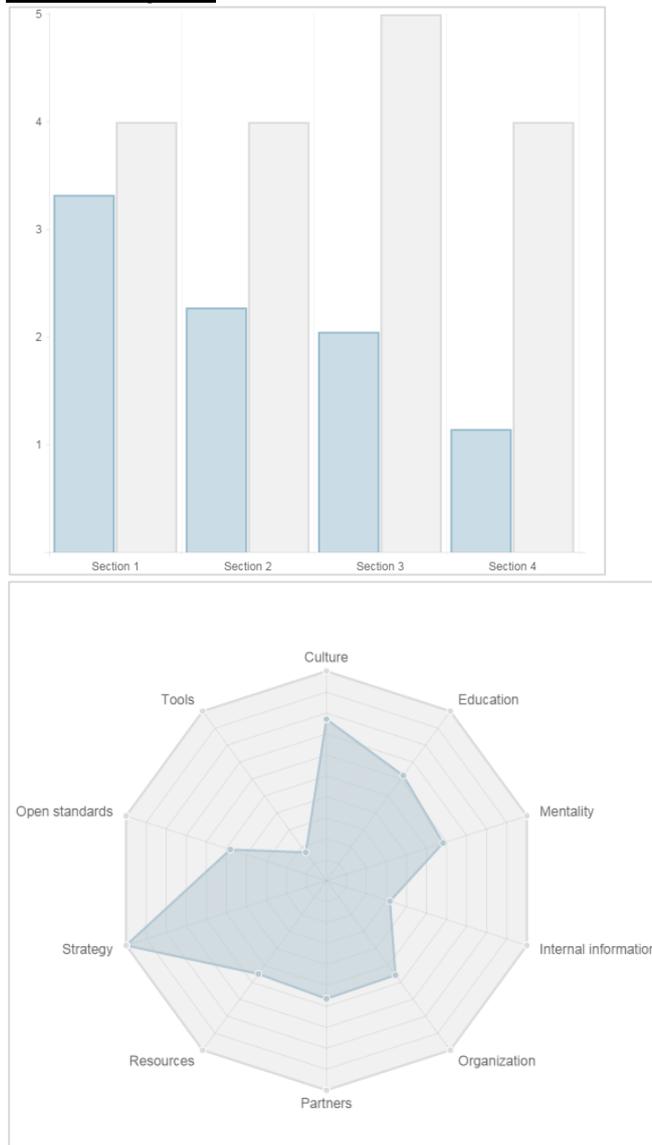
Figure 6: United Kingdom

The scan of the UK shows a high score on the section management and organization and on strategy.

Blended results
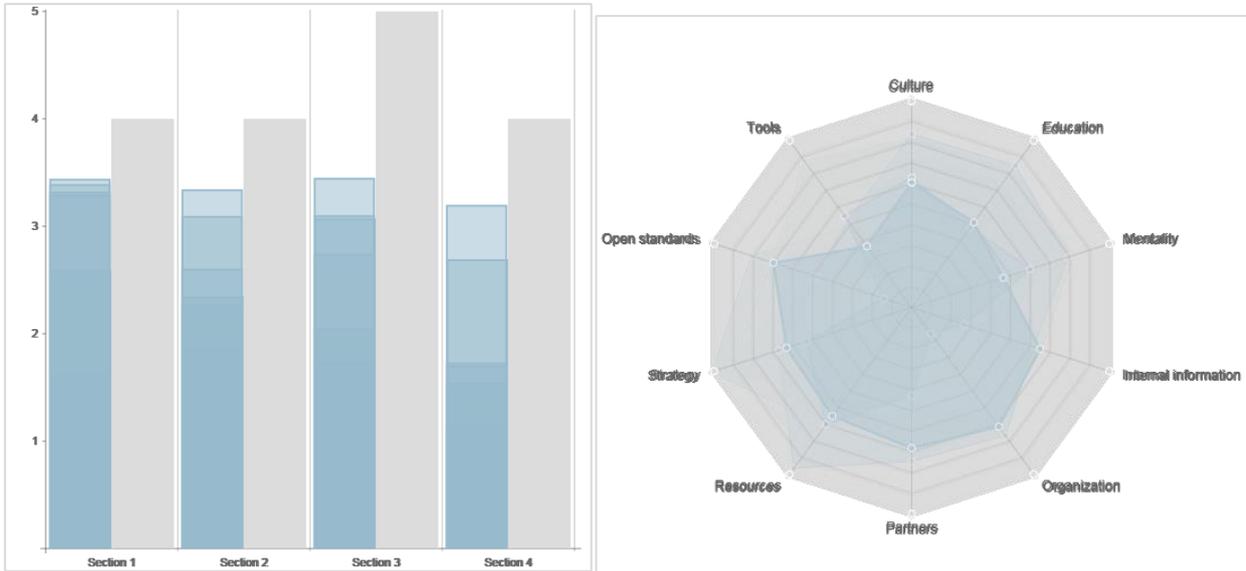
Figure 7: Blended results of the six countries

Although it is difficult to compare results, TNO generated also the blended results of both diagrams. Here we see that the section management and organization has relative high score and the section technology and applications seems to lag behind. The aspects are quite in balance, only the following aspects: tools, mentality and education have a lower score.

1.3 Financial inventory

We have used the available information of the S3 CEDR countries. For not all the subject of this inventory was information available, which is due to the fact that in some budgets the BIM-part was not explicit. If possible we have tried to make a reliable estimation (best guess). If not possible, the numbers are not in the figures or tables. Because some NRAs maintain also rail or waterways, the numbers are not only meant for roads but have a wider scope.

Investments in BIM
In table 1 you can see an overview of the investments in BIM development programs in the CEDR S3 countries, both on NRA-level and on national level. Most countries have BIM programs on strategy, standardization (for example objecttype libraries), manuals and guidelines. Besides that there is implementation in projects, sometimes with open BIM standards. There are also some international projects.

Table 1 Investments in BIM development programs. CEDR S3

Country	BIM program Level	Period	BIM implementation projects	Costs (M Euro)
The Netherlands	NRA	2012-2017	5 large projects, p.e. highway A1-A6; open BIM	24,9 M
	National level (Building Information Council)	2013-205		3 M
Sweden	NRA	2012-2014	6 large projects p.e. Stockholm bypass (open BIM) and about 30 smaller road and rail projects	3 M
	National level (BIM Alliance)	2014		0,5 M
France	NRA			
	National level (COMMUNIC and MINND)	2007-2017	several large projects (open BIM) p.e. L2 Marseille, expressway Qatar	7 M
Finland	NRA		City rail loop (Pisara (open BIM) and several other BIM projects	
	National (ViRe-SMART, PRE, infraFINMBIM)	2010-2014		6,6 M
Norway	NRA (Handbook)		about 50 projects (limited open BIM)	0,12 M
	National			
Denmark	NRA (The digital construction)	2012-2017	highway Herning-Holstebro	1 M
	National			
UK	NRA			
	National (UK BIM Taskforce)		Ringroad London, crossrail London,..	13,4 M
International	EU V-CON project	2012-2016		2,7 M
	IFC Alignment buildingSMART	2014-2015		
Total				59,6 M

The total costs are about **59,6 M Euro** investment in BIM Development Programs for the period 2007-2017 in the S3 CEDR Countries including European research and development projects (about **6 M per year** on average). The Netherlands and the UK have the biggest investment programs. BIM implementation is sometimes and mostly the big projects (ring road, crossrail, ..). There are not yet BIM implementation projects between more countries together.

Estimated cost savings
Figure 1 illustrates the estimated cost savings percentage by using (open) BIM technology in the design and construction order portfolio for different CEDR S3 countries in 2014 and 2020.
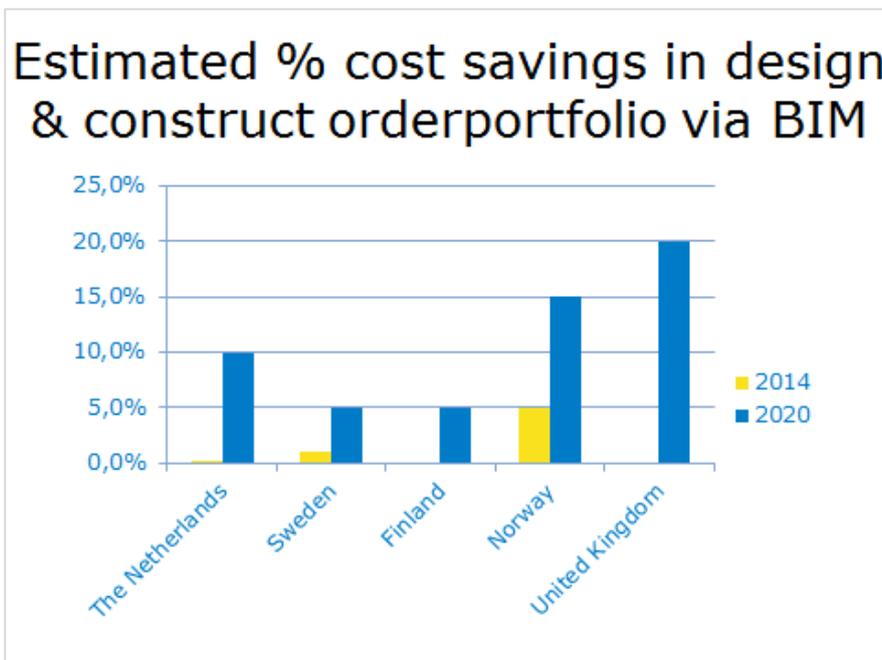
Figure 1: Estimated percentage cost savings design & construct in 2014 and 2020

The estimated percentage in 2014 varies between 0,1 and 5 %, because BIM is still used in a limited way or on a pilot basis. The estimated yearly cost savings percentage for 2020 varies between 5 and 20%. This percentage can even grow further, for example the estimation of the UK government is 30% in 2025.

Estimated savings by BIM in design&construct for NRA in 2020

Savings (M Euro)

[Bar chart showing savings in M Euro for The Netherlands (~30), Sweden (~133), Finland (~84), and Norway (~130). Y-axis ranges from 0 to 140.]
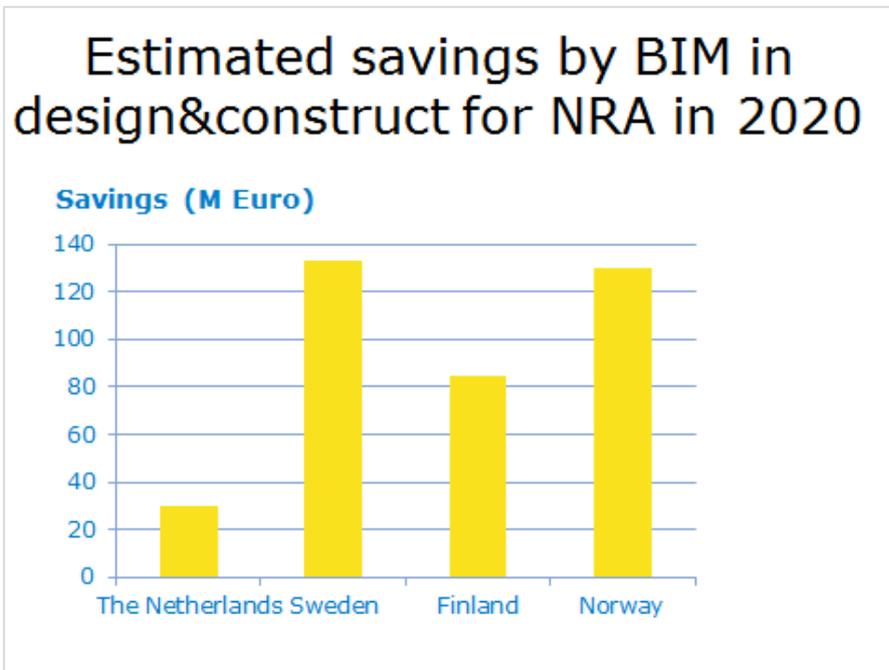
Figure 2: Estimated cost savings by BIM in design and construct for NRA in 2020

The total order portfolio for design, construct and maintenance of Sweden, Finland, Norway and the Netherlands together in 2014 is 12,2 Billion Euros. The design and construct order portfolio of these countries is 4,6 Billion Euros. The estimated structural cost savings for these countries for design and construct is about **378 M Euro per year** from 2020 and further (ca **8,2%),** based on the amount in the portfolio 2014. The total cost savings, with also the order portfolio for maintenance taken into account, will even be higher.

Information from literature
Danish OpenBIM study reports substantial cost reductions during lifecycle (source "DTU Byg Rapport SR 12-06):
- Increase of 70% construction productivity
- Reduction of bid price by 30%
- Reduction of design faults found on site by 90%
- Reduction of cost of FM/Operation by 20%

Mc Graw Hill Smart Market Report 2014 reports from the contractors point of view:
- Top 5 BIM Benefits (cited by contractors)
    1. Reduced errors and omissions
    2. Collaboration with owners/design firms
    3. Enhanced organizational image
    4. Reduced rework
    5. Reduced construction cost
- Over the next 2 years, contractors expect the percentage of their work that involves BIM wil
- increase by 50% on average

- 75% of contractors report a positive ROI on their BIM program investment (Western Europe 84%)
- China: "Owners will drive BIM use…", "Owners seeking to improve facility management are emerging as key driver of adoption (of BIM) in China".

NBS Report 2013 reports:
- "There has been an 18 % improvement in productivity in UK Government projects using BIM" (quote)
- Barriers to BIM adoption: "Clearly the big three issues are: lack of expertise, lack of standardized tools and protocol, and lack of collaboration".

1.4 Conclusion

- There are different BIM approaches, some of them starting bottom-up from a technology push and some of them starting more top-down from a strategy pull, or a combination. There are also differences between the different countries because of:
    - policy setting
    - maturity of BIM development
    - current efficiency in dealing with information
    - effectiveness of BIM implementation in project practice
    - chain connection in the sector as a whole.
- From the maturity scan we see in general that the section management and organization has relative high score and the section technology and applications seems to lag behind. The aspects are quite in balance, only the following aspects: tools, mentality and education have a lower score. This corresponds to the barriers for BIM adoption as found in literature (NBS report 2013).
- The European CEDR countries invested about 59,6 M Euro in BIM development programs for the period 2007-2017. The investments are done on national level; the S3 countries feel a need for a development on a European level via a joint investment.
- BIM implementation projects at NRAs are delivered in open BIM (often created in closed BIM in the supply chain) and mostly at design & construct level.
- The BIM implementation projects in the different countries show that there is a real market for open data and open BIM technology and also a clear need from the CEDR S3 countries. Via open standards we can use structured open data, which is a basis for developing tools/apps on it. Through the structured open data the NRAs can use the data during the life-cycle (data models will not change but the technology will change, via open data standards there is no vendor lock-in). So it is about interoperability, which will be important for modern ways of asset management.
- The estimated structural cost savings for The Netherlands, Sweden, Finland and Norway together for design and construct is about 378 M Euro per year from 2020 and further (ca 8,2%), based on the amount in the portfolio 2014. In 2025 this percentage gets even higher, about 30% in the UK ("three for the price of two").
- The total cost savings, with also the order portfolio for maintenance taken into account, will even be higher. It is important that there is a stronger connection to asset management because BIM is key to their business, so the awareness has to grow.
- There is a very high ROI: investment in BIM programs versus cost savings
- A sustainable governance structure for open BIM standards is important, to realize cost savings and to implement the EU policy on open BIM standards in an effective way.

Annex II - EU BIM task Group; Work program 2014-2017

EU BIM Network
Work Program for 2014 – 2017

This schedule describes the high level work program for the EU BIM Task Network through 2014 – 2017. It focuses on year 1 activities (2014-2015) and for years 2 and 3 it is more generalized.

The program is structured in to five functions:
Organization Structure & Management
Principles and Practices
Communication
Public Client Procurement Support and
Stakeholder Leadership & Coordination)
as follows:

x. Function (ie. the broad grouping of deliverables or activities)
x.x Deliverable or broad activity (ie. what will the Network produce, or services it provide)
- Activities (what actions or tasks should be performed)
- Resources required (e.g. internal EU BIM Network or external resources required)
- Timeframe of work (ie. the activity for year 1 or for year 2/3)

1. Organization Structure & Management	
1.1	Develop Vision statement • Produce a vision statement from public estate owners of the outcomes required by clients and how BIM can be introduced to enable these outcomes. • The internal members of the EU BIM Network will develop this. • *Year 1 Work required*: One workshop meeting to agree a common vision and an editor to draft and revise a statement that all members agree.
1.2	Identify and recruit new members to the EU BIM Network • Grow the Network with new members from countries currently not participating through networks of existing members and EC referred contacts The internal members of the Network will actively participate in the outreach program. *Year 1 Work required*: conference calls, e-mail and attending conferences and meetings across Europe (expect to limit to 10 travel meetings during year 1).
1.3	Produce mobilisation and full implementation plan • Produce detailed plans for the development of work, produce a meeting schedule and agree milestones review of developed work. • The internal members of the Network will produce the full implementation plan. • *Year 1 Work required*: conference calls, e-mail and one workshop meeting.
1.4	Host EU BIM Network website Phase 1 • Provide an internal communication portal for the EU BIM Network to collate and share documents and materials relevant to best practices, guides and protocols implemented across Europe. • Provide a platform for external communication to other European public owners and to the European construction sector presenting the EU BIM Network, its vision, its agenda and how to interact with the Network.

	• Website should communicate endorsement by EC "facilitated by EC" or a similar statement of support • The EU BIM Network will seek external resources to produce and host this website. • *Year 1 Work required*: organise the digital infrastructure for the website, produce the website framework and basic content (e.g vision statement, notable events, key contacts). • *Year 1 Work*: attending a workshop of nominated members in Brussels (1 meeting of 10 people) • *Year 2 and 3 Work required*: update and maintain the website content, e.g. updating contacts, guides, event calendar.
1.5	**Identify funding support for the Network for 2015-2017** • Ensure that the Network has funds and support to operate its core function during 2015-2017 • The EU BIM Network will identify and seek support using its own resources.
1.6	**Create an official base and entity for the European BIM Network** • The EU BIM Network aims to be recognised as a European entity – and as such it intends to hold a Brussels postal address. • The EU BIM Network will seek advice from the European Commission and other entities (similar to the BIM Network) for the development of an official entity in Brussels. • Year *1 Work required*: identify and develop the legal and administrative infrastructure required for a Brussels based address.
1.6	**Create an official base and entity for the European BIM Network** • The EU BIM Network aims to be recognised as a European entity – and as such it intends to hold a Brussels postal address. • The EU BIM Network will seek advice from the European Commission and other entities (similar to the BIM Network) for the development of an official entity in Brussels. • Year 1 Work required: identify and develop the legal and administrative infrastructure required for a Brussels based address.
1.7	**EU BIM Network team meetings & EC DG Briefings** • The EU BIM Network aims to hold two full meetings every year in Brussels with three intercessional meetings of a smaller quorum of its members to review and produce materials. • The EU BIM Network requests travel expenses for attending two annual full member meetings. • The EU BIM Network requests assistance of EC for meeting spaces. • Year 1 Work required: Agree the Network's meeting calendar to coincide with the Implementation Plan (1.3).
1.8	**Self-funding European BIM Network for Post-2017 alignment** • Ensure that the Network has support to further its objectives after the initial program (2015-2017)
	2. Develop Principles & Practices
2.1	**Collate and share best practices from the European experience of introducing BIM to public works** • Issue a request for example of best practices from the EU BIM Network members (send email invitation endorsed by EC). Best practice examples of pilot projects, technical guides, commercial and contractual protocols adopted. Examples of bottle necks and issues to avoid and examples of ROI for public clients and supply chain actors. • Participants will be expected to reply on-line using the Network's website as a repository of information. • The Network will seek external resources to assist with the survey development and on-line collation of best practice materials • Year *1 Work required*: Develop and issue a survey request to all members. Manage responses via the Network's website (1.4)
2.2	**Produce guidance for agreed areas of commonality for the introduction of BIM to Europe's public works** • Activities include a series of workshops and conference calls within the members to identify common principles and practices across topics: (standards,principles and methods, dictionaries, contracts and commercial terms, insurance and security). • The Network will use its internal resources and its networks in workshops to develop the common mapping

	• Meeting space for the workshops will be requested of external stakeholders • *Year 2 Work required*: develop an initial mapping of areas of commonality • *Year 2 & 3 Work required*: develop guidance for the defined areas commonality (developed in year 2)
2.3	Produce a document of common language for public clients to use across Europe • Develop an EU level lexicon of terminology to aid the introduction and understanding of BIM across the public client community • This document will be developed by the EU BIM Network members • Meeting space for the workshops will be requested of external stakeholders • *Year 1 Work required*: Agree the Network's key terms and definitions in relation to the introduction of BIM • *Year 2 Work*: Introduce the Common lexicon to the national contracting terms and BIM programs.
2.4	Produce a common learning outcomes framework for public clients to use across Europe • Workshops and document exchange between members to develop an EU common learning outcomes framework to increase capability and capacity across the EU market • This document will be developed by the EU BIM Network members (members may include local education and training experts in the drafting process) • *Year 1 Work required*: Agree and document the common learning framework • *Year 2 Work required*: Introduce the learning framework to national education and training bodies
3. Communication & Conferences	
3.1	Design and execute a communication strategy to European target audiences (i.e. public owners; standards groups and professional associations; construction industry private sector firms) • Use the EU BIM Network website as a platform for communication, workshop and develop key messages and material. Communicate the Network's vision statement (**1.1**) and desired outcomes, benefits for adopting digital practices. Share best practice guidance as collated **(2.1)** • Arrange a Launch conference for the Network in Brussels • The Network will use its internal members and acquire external resources to assist with promotion of its core message through its website, and to arrange a 'Launch Conference' for the EU BIM Network • Meeting space for the workshops will be requested of external stakeholders • *Year 1 Work required*: Agree key messages to communicate and deliver through arranging a conference, supporting other conferences and using the EU BIM Network website. • *Year 1 Work required*: Develop media relations in order to promote the EU BIM Network and its core message.
4. Deliver Public Client Procurement Support	
4.1	Develop client engagement plan with localization strategy • Using workshops and consulting with member state experts the BIM Network would over the long-term seek to develop recommendations for the adoption of BIM under the public procurement directive at the national level. • Develop a guidance note for the use of the EU BIM Network's developed materials to support public procurers at the member state level. • The Network's members would develop this guidance in consultation with local experts. The Network would seek information and advice from the European Commission and its DGs responsible for the procurement directive. • *Year 1 Work required*: Identify the key stakeholders in the member state and bring these procurement representatives in to the EU BIM Network conversation. • *Year 2 & 3 Work required*: Develop the guidance materials to support the introduction of BIM to public works and public procurement policy.
4.2	Provide on-going support to EU public clients introducing BIM

	• Using workshops and consulting directly with member state procurers, the EU Network will provide guidance and information to member states adopting BIM in to its national procurement frameworks. • The Network's members will provide this service. • Year *1 Work required*: Identify the key stakeholders in the member state and bring these procurement representatives in to the EU BIM Network conversation.

5. Stakeholder Leadership & Coordination

5.1	Outreach and foster partnerships with other major regional client bodies (e.g. Asia-Pacific, Singapore, South Korea, Japan, Hong Kong, Malaysia, China, Australia; and US public entities) • In order to create critical mass of support for the common principles developed, the EU BIM Network will develop and execute an outreach program to major global stakeholder communities. The aim will be to create common language across these global stakeholders and to grow the market for digital services in the construction sector.
5.2	Engage with priority supplier groups (e.g. ISO, CEN, CEDR, DIN, BSI, ASI, BuildingSmart, Technology vendors etc) • Provide steerage and advice to major supplier stakeholders • Internal EU BIM Network members would undertake representation to the major supplier groups • *Year 1 Work required*: support ISO and CEN BIM guidance development to align with the EU BIM Network common learning framework, common language and common practices. • *Year 2 Work required*: continue to support European and global guidance development to align with the EU BIM Network common learning framework, common language and common practices
5.3	Support and engage with EC DG Enterprise (and Connect, Internal Market, Energy) initiatives and programs
5.4	Mobilize self-sustaining regional and discipline specific communities

Annex III – Leaflet and poster on 'what is BIM?'

What is BIM - Page 1 - see: http://www.bouwinformatieraad.nl/free-knowledge-products/

of computer applications, including 3D modelling applications. From this viewpoint, a 3D model is merely a geometrical representation of a selection of all available data.

Why choose BIM?

The main objective of the BIM program initiated by the BIR is to enhance the quality, continuity and competitiveness of the Dutch building industry. The use of BIM will lead to better, more efficient and less expensive construction. The benefits of BIM affect the complete supply chain; individual companies can improve their competitive position too. BIM enables the building industry to fully benefit from modern information and communication technology.

BIM is still in development. Companies and organizations in the Dutch building industry have different levels of BIM maturity. The BIR has distinguished four different BIM levels, which have been described in BIR leaflet no. 1 *Dutch BIM levels*. This leaflet was designed to help companies establish their own BIM maturity level. The BIR encourages companies and organizations to strive for ever higher BIM levels.

More than just IT

The implementation of BIM within a company or organization entails more than just implementing new IT tools. To be able to reach the desired goal, it is important to invest in areas like Management and Organization, People and Culture and Processes as well. The BIR offers guidance for each of these areas, for example through the publication of leaflets.

Information technology

Standardization is crucial for the successful application of BIM in building projects. The BIR is committed to encourage the use of 'open' BIM standards for the information exchange; standards that are freely available and independent of any

specific software or software supplier. By using open BIM standards, all participants in a building project can continue to use their own software and still exchange and reuse data. The *Open BIM standards leaflet* provides an overview of which standards are to be applied depending on the BIM level (also see BIR leaflet no. 2). More information about the open BIM standards can be found – in Dutch – at the BIM Loket website (www.bimloket.nl). The BIM Loket Foundation, founded by BIR co-ordinates the development and management of the Dutch open BIM standards.

People and Culture

Working with BIM and BIM supported co-operation in projects requires changes in the culture and behavior of building partners. This may well be the biggest bottleneck in the implementation of BIM. Furthermore, working with BIM requires different skills and competences from employees on all levels of the organization. Leaflet no. 3 *BIM roles and competences* describes the required skills and competences of employees that perform specific BIM roles in a company and/or in projects. More information in English about BIM roles and competences can be found on www.bouwinformatieraad.nl/free-knowledge-products.

Processes

Many questions exist about the legal consequences of working with BIM. What rules should be upheld concerning liability when different parties are working in an integrated building model? Who is the owner of the model? Does BIM require the application of new contract models? The answers to these and other questions can be found in Leaflet no. 4A *BIM legal, general*. Leaflet no. 4B *BIM legal,*

checklist BIM working arrangements offers a checklist for arrangements that must be agreed upon between building partners to ensure the success of a BIM project. Such working arrangements are often drawn up in BIM Protocols and/or BIM Execution Plans. To create more uniformity in contractual and working arrangements regarding BIM, BIR will issue a National BIM Protocol Model (to help establish contractual agreements between clients and suppliers) and a National BIM Execution Plan Model (to help establish mutual BIM working arrangements between partners in the supply chain).

Management and Organization

Working with BIM changes the business. As the building partners reach a higher level of BIM maturity, the way of co-operating will change and become less scattered and more integrated, less consecutive and more concurrent. This change is needed, as clients pose more integral, functional questions, questions that call for integrated answers from supply chain partners. To be able to give integral answers, partners must intensify their co-operation. BIM leads to new contract models, new business models and above all to a different, strategic distribution of labour and employees. Management has a pivotal position in reaping the practical benefits of working with BIM. In other words, BIM is a subject for the boardroom table and should be a part of the strategic agenda of every company in the industry. The challenge is to focus on integral quality. The result will be a better and more efficient way of working throughout the sector of industry and added value for society!

What is BIM - Page 2

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BIM use: see: http://www.bouwinformatieraad.nl/free-knowledge-products/

Annex IV - Abstract EU-Proposal EURODICTI and abstract CEDR call "Asset Information using BIM"

Abstract Eurodicti proposal

Building information management is of vital importance to increase the performance of the infrastructure network (rail, road, urban areas). Interoperability based on open standards is essential for digital exchange of information between all construction partners (engineers, contractors, asset managers, operators). Data dictionaries enable this. Currently the IT market offers solutions based on proprietary standards which introduce vendor locked in situations and limit the exchange in the value chain.

EURODICTI aims at implementing BIM, based on open international standards in the infrastructure sector following the European Interoperability Framework. In 2010-2014 serious investments have been made on national level to develop common open access data dictionaries. An open European market requires European coordination to benefit from these national investments and to connect their (future) outcomes. The objective of EURODICTI is to create a networking platform that serves as a starting point to the creation of a European open access data dictionary. EURODICTI will:

- Survey and assess existing data dictionaries - Define general principles for architecture of data dictionaries, for taxonomies and properties of the assets
- Define use cases with specifications to be able to experiment the startup of implementation
- Disseminate the results to connect partners in the value chain across Europe, including CEN, CEDR and ENCORD
- Create the conditions and the principle of a network organization that will serve as a starting point for the future development of a European data dictionary

The project will enable a swift transition towards zero traffic disruption by minimizing the inefficiencies due to bad communication. The work will be carried out by key organizations on (inter)national level with an extensive network, a wide acceptance in the sector, an extensive knowledgebase and active in the forefront of the development of BIM based open standards

Abstract CEDR-call proposal "Asset Information using BIM"

The aim of this research program is to improve interoperability of the European NRAs and its stakeholders by embedding the use of Building Information Management based on open standards in their Asset Management and Construction processes.

The objects of the research are:
- To identify the needs among Europe's NRAs and its major stakeholders regarding the exchange of Building Information in a vendor neutral way4 during the life cycle of Assets.
- What national Building/Asset Information knowledge can be used for implementation on European level and for further development.

This call has the following four expected results:

A. Exploration of Procuring Asset Information for better projects and Asset Management Systems

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4 A vendor neutral way means that the ICT is functioning independently from the software used by a specific vendor

B. Exploration of BIM data structures
C. Design for common principles for a European object type library
D. Design and test a basic European object type library and open BIM standards Reasons for the Transnational Research Program

The main reason for this Transnational Research Program is to gain better knowledge and guidance on Asset Information using BIM.

Management of asset information in the NRAs contracts become a more and more of vital importance of the NRAs work and has a big effect on costs and quality. It is well known that a considerable amount of failure costs or wrong delivery at the infrastructure works is caused by poor quality or poor exchange of the asset information between the contractual partners (NRAs, contractors). This is valid for the process of construction works where information out of the asset management systems needs to be delivered to the contractor and where the as built information needs to be received and placed in the asset management systems. To fulfill this requirement in an efficient manner:

• Proper procurement of information requirements is needed
• A proper data structure is needed
• Reliable data is needed (validation of the data).

The NRAs are more and more dependent on a satisfactory level of quality of the information about their network in their asset management systems. On a national scale a number of activities have taken place in this field. However NRAs feel the strong need to bring the results on the European level and see what we can commonly use in Europe. NRAs see that the markets are becoming more and more international (business wise and IT wise). So there is a need for harmonizing national developments on a European scale in order to create a level playing field for building industry and ICT industry. Hence it seems a logical step forward that CEDR members starts to collaborate in this field, since on national level a significant amount of work already has been carried out.

The main reason for CEDR's Transnational Research Program to procure this research is to:
• gain better knowledge and guidance of how to manage asset information during the lifecycle for internal development by making use of modern IT technologies
• steer the development at other discussion groups into a more demand driven development rather than a supply driven development
• benefit from national developments and experiences resulting in a reduction of costs and acceleration of the development.
• create common understanding about open standards that are suitable or need to be developed

Although the BIM development in Europe is already active for many years now, the dominant players in infrastructure (NRAs and construction and engineering companies) have only started to become active since the last two or three years. Since the character of BIM really is international and the procurement of the NRAs construction and maintenance works become more and more international, international cooperation between Europe's NRAs is a key factor for success. Dominant IT companies whose products are widely used in the construction industry are only willing to invest in new developments when the international business case is there. Hence it seems very beneficial for each individual CEDR member to contribute to this research activity.

NRAs have two main activities: asset management and procurement of their designing, engineering, construction and maintenance works.

For the maintenance of existing networks asset managers need reliable information for the day to day operation of the road and for their strategic planning. It is obvious that the level of detail varies or operational type of work to strategic planning.

Therefore the call has the following four expected results:

A. Exploration of Procuring Asset Information for better projects and Asset Management Systems
In this activity it needs to be investigated how asset information is required to be exchanged in infrastructure contracts (Design, Engineering, Construction and Maintenance) across Europe. What type of information/data is exchanged and what structure/format is used and what type of (open) standards are used for the exchange. This may vary in each country and per type of contract.
The results of this research will be used to decide what can be done on a European level to accelerate embedding of Digitizing Asset Data and BIM methods in the sector.

B. Exploration of BIM data structures
In this activity a further elaboration of the types of data structures used by NRAs is explored. Research can include data structures of BIM models and what dominant commercial information management systems (their interfaces) are used. Emphasis should be given to the ones using open standards. The investigation needs to be done on the level of asset management, project management at NRAs and at major contractors. Furthermore the internal strategy for maintaining/developing Asset management (systems) needs to be considered.
The result of this activity leads to requirements for data structures applicable on a European level and provides recommendations for improving existing asset management systems and object type models for implementation.

C. Design for common principles for a European object type library
In this activity common principles, criteria and requirements for the design of a European object type library need to be derived using the results of activity A and B. It needs to be

investigated which (open BIM) standards need to be taken into account of these principles.
Make recommendations regarding:
1. the contents of a European object type library and
2. the use or development of open BIM standards.
The level of detail in a European Library should at least include the basic elements of a road network; like highways, two-way lanes, crossings, bridges, pavement and road furniture.

D. Design and test a basic European object type library and open BIM standards
In this activity a basic European object type library has to be developed, constructed and documented. The object type library should contain as designed, as built and as maintained (different life cycle) phases. Testing of the library and recommended open BIM standards to implement can be done on data sets provided by different involved NRAs.

The items A, B and C should be finished within one year to have at least one year for designing and testing (item D).

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ANNEX V - Publication in Magazine PanEuropean Networks

Benefits and Risks for Governmental Asset-owners using Building Information Management at construction

Benefits of using BIM

During the last decade several publications show that enormous amounts of money can be saved using BIM at construction sites. See below the five main benefits and the corresponding Figure 1 in the UK Governmental BIM Strategy 2025:

• Better information during life-cycle
• More efficiency: lower costs
• Higher quality
• More transparency and accountability
• More innovative and competitive European Industry

Figure 1: Benefits UK Government BIM Strategy 2025

Building Information Management (BIM) is indeed a way of efficient digital transfer of building related information (interoperability), and may contribute in reducing failure costs, enhance transparency of planning, building and maintenance processes, communication (visualization) and less information loss. This will often lead to effective construction and asset management processes and a better quality and a faster construction result. The use of 3D BIM models plays a significant role in the design phase. Not only construction companies but also (the often) governmental asset-owners will benefit and save money on the long run with the application of BIM. To achieve these benefits effective policies, processes and transparent transfers of data based on open standards needs to be in place in the whole value chain not only nationally but also internationally. This means that each organization participating in the value chain needs to

adapt to the requirements worked out in these policies, processes and standards in order to achieve the goal of digital interoperability in the construction industry.

Therefore cooperation started on different scales, company, national and international level, in the construction sector and the IT sector, during the last few years to guide this innovative BIM-improvement.

Risks of using BIM

Nevertheless some risks may occur if you initiate and use BIM. Embedding BIM at your governmental institute has to be done step by step and the available BIM technology on the market needs to be clearly understood in order to apply these correctly in the specific phase of the construction process where it is designed for. For instance 3D models are often identified as BIM and vice versa which is not the case. BIM aims to control information in the whole value chain, while 3D models are especially usefull in the design phase. 3D models require Asset Information from databases as a basis. It is important to realize that two items may limit your expectations:

*   BIM-models tend to become big, so make sure what kind of information you really need in the maintenance phase (maintenance-parts of the construction) in order to limit the amount of asset data you receive.
*   The naming of objects and their corresponding properties in 3D BIM models may differ from the naming of the objects in assetmanagement systems.

As a consequence this generated information might be of low importance for the assetmanager.

Furthermore all digital models have to be operated, which might involve high costs to maintain and might need specific applications/databases in the assetmanagement . If you ask different construction parties to use BIM-models they often have different applications using their models and different databases to generate information. Make sure you get the information in a standard way, that will fit and automatically flow into your own databases otherwise this will cost you additionally. Information loss during the construction phase and later are often the costs for asset-owners!

Recommendations

It is recommended to:

*   Use open BIM-standards. Asking for the usage IFC, IFD, COINS and CEN/ISO-standards for data-transfer and structured semantic processes in governmental procurement is highly recommended in order to create a market for application of BIM.
*   Invest in national and International Standardization groups. Institutes like Building Smart International, OGC and CEN/ISO can facilitate the development and uniformity of these standards. Good examples of using these IFC-standards and COINS-standards for BIM can be found in Scandinavia, UK, France and the Netherlands (figure 2).
*   The European commission to invest in European guidelines and legislation regarding procurement and open standards to ensure interoperability in the construction and maintenance phase. And to engage the IT sector to embed these open standards in their products.
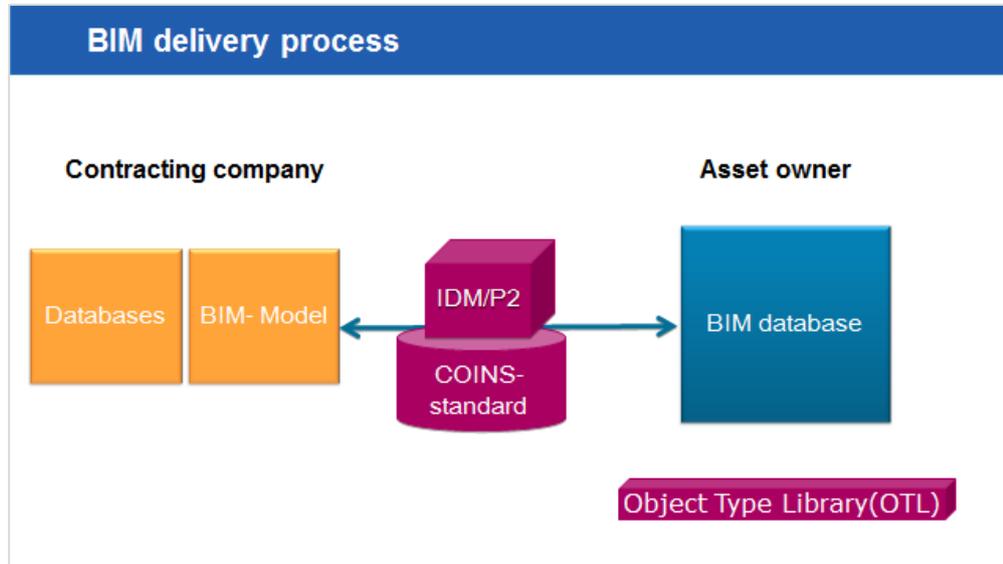
Figure 2: Dutch example of BIM-delivery process with the open information exchange standard COINS in Infrastructure

Annex VI - Procurement Questionnaire

Procurement methods for infrastructure projects

- An overview of how the NRAs of the participating countries in the CEDR project "S3 Standardization of Information in Infrastructure Sector" procure digital information in contracts.
- The presentation is based on answers to the questionnaire found here: https://goo.gl/forms/VUG52H58X2ki2GQs1
- It is recommended to read the questionnaire when going through the results in this presentation, as the questionnaire contains information about terms and context.

Contents

1. Participating countries
2. Types of public procurement procedure
3. Selection methods
4. Project delivery method
5. Standards for tender and contract templates
6. Tender templates for information requirements
7. Basis data
8. Transfer of basis and design data from NRA to contractor/designer
9. BIM projects

1. Participating countries

Country	Name	Organization
UK	Jackson,Philip	Highways Agency
Norway	Thorsen Thor, Sigurd	Norwegian Public Roads Administration, Directory of public roads
Sweden	Malthe, Lars	the NRA and construction contract committee
Netherlands	Winkels, Herman	Rijkswaterstaat, GPO
Denmark	Jensen, Rasmus Fuglsang	Division of construction and maintenance
Finland	Perttula, Tiina	Finnish transport agency, Legal Services and Procurement, Project Management

2. Types of public procurement procedure

Country	2.1 What public procurement procedures do your organization use for infrastructure projects?
UK	Open procedure, Restricted procedure
Norway	Open procedure, Restricted procedure, Negotiated procedure, Competative dialogue
Sweden	Open procedure, Restricted procedure, Negotiated procedure, Competitive dialogue, Framework agreement, PCP
Netherlands	Open procedure, Restricted procedure, Competitive dialogue, PPP: Design Built Finance and Operate
Denmark	Open procedure, Restricted procedure, Negotiated procedure, Competitive dialogue, Framework agreement
Finland	Open procedure, Restricted procedure, Negotiated procedure, Competative dialogue

Country	2.2 What three types of public procurement procedures do you use the most?
UK	
Norway	Open procedure, Restricted procedure, Negotiated procedure
Sweden	Open procedure, Negotiated procedure, Framework agreement
Netherlands	Open procedure, Competitive dialogue, PPP: Design Built Finance and Operate
Denmark	Open procedure, Restricted procedure, Framework agreement
Finland	Open procedure, Restricted procedure, Negotiated procedure, Competative dialogue

3. Selection methods

Country	3.1 What type of selection methods do you use
UK	Best-value selection, Framework Selection
Norway	Low-bid selection, Best-value selection
Sweden	Low-bid selection, Best-value selection, Qualifications-based selection
Netherlands	Low-bid selection, Best-value selection, Qualifications-based selection
Denmark	Low-bid selection, Best-value selection
Finland	Low-bid selection, Best-value selection, Qualifications-based selection

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4. Project delivery method

Country	4.1 What types of contract/project organization do you use?
UK	1 Design, 2 Build (equals Design-bid-build?), 3 Maintenance
Norway	1 Design, 2 Build, 3 Maintenance, 4 Design-bid-build, 5 Design and build, 9 Public private partnership (PPP)
Sweden	1 Design, 2 Build, 3 Maintenance, 4 Design-bid-build, 5 Design and build
Netherlands	5 Design and build, 6 Design-build-operate-maintain
Denmark	1 Design, 2 Build, 3 Maintenance, 5 Design and build, 12 Concession
Finland	1 Design, 2 Build, 3 Maintenance, 4 Design-bid-build, 5 Design and build, 6 Design-build-operate-maintain, 9 Public private partnership (PPP), 13 Alliance

5. Standards for tender and contract templates

Country	5.1 Standards for tender templates
UK	Framework selection according to PAS 91: http://www.highways.gov.uk/about-us/procurement/supplier-selection-and-development/ha-pre-qualification-pack/
Norway	https://www.standard.no/en/toppvalg/about-us/standards-norway/#.VpZDJMShSYD
Sweden	http://www.trafikverket.se/en/startpage/
Netherlands	
Denmark	http://vejregler.lovportaler.dk
Finland	http://www.hankintailmoitukset.fi/fi/ -> near future "cloudia"

Country	5.2 Standards for contract templates
UK	http://www.highways.gov.uk/about-us/procurement/supplier-selection-and-development/model-contract-documents/
Norway	http://www.vegvesen.no/s/bransjekontakt/R763/Bygg/
Sweden	http://www.foreningenbkk.org/index.php/the-construction-contracts-committe/
Netherlands	
Denmark	http://vejdirektoratet.dk/udbud
Finland	http://www.jhs-suositukset.fi/web/guest/jhs

6. Tender templates for information requirements

Country	6.1 Are your tender templates accessible online?
UK	Not sure
Norway	Accessible for public download
Sweden	Accessible in procurement system for providers only
Netherlands	Accessible for public download, Accessible in procurement system for providers only
Denmark	Some are accessible
Finland	Accessible in procurement system for providers only, Delivered on paper, not online, Other, add description in next field, possible to get on paper too. In some cases material could be on paper and on online both.

Country	6.2 Are your tender templates describing information deliverables translated to English?
UK	Yes
Norway	No
Sweden	No
Netherlands	Yes
Denmark	They are in the process
Finland	No

Country	6.3 Do your organization use different tender templates for BIM-projects and traditional (drawing based) projects?
UK	No
Norway	No
Sweden	No
Netherlands	Yes
Denmark	
Finland	No, Other, add description in next field, but it is possible to have guidance boxes on template, so description in tender documents varies

Country	6.4 What proportion of your tenders ask for BIM-related information?
UK	Yes (add a brief description in next field), Framework selection only
Norway	40 %
Sweden	in the future all new investments will be required with BIM,
Netherlands	60 %
Denmark	100% level 1 BIM
Finland	Depend what you are asking. If only design in new investments then almost 90 %. If maintenance then approximately 10% (depending what you are considering as "maintenance BIM". We ask for information but is it always BIM?

Country	6.5 What is the format of your tender templates for BIM procurements?
UK	To be advised
Norway	Text-documents (word etc)
Sweden	Editable PDF documents
Netherlands	Part of dedicated procurement software, Text-documents (word etc.)
Denmark	Web-form
Finland	Web-form, Part of dedicated procurement software, Text-documents (word etc)

7. Basis data

Country	7.1 Who is responsible for the quality of basis data?
UK	Principal is responsible for the quality of basis data, but other parties deliver/produce the data, Consultant is responsible for basis data, Contractor is responsible for basis data
Norway	NRA is responsible for and provides basis data, NRA is responsible for the quality of basis data, but other parties deliver/produce the data
Sweden	NRA is responsible for the quality of basis data, but other parties deliver/produce the data
Netherlands	NRA is responsible for the quality of basis data, but other parties deliver/produce the data, Constructor is responsible after new construction
Denmark	NRA is responsible for and provides basis data
Finland	NRA is responsible for and provides basis data, Contractor is responsible for basis data, NRA is responsible for some basis data. Like land surveys in some cases. It depends on procurement method we are using.

8. Transfer of basis and design data from NRA to contractor/designer

Country	8.1 Do your organization use a dedicated software system for digital data-transfer on internet
UK	To be discovered
Norway	Yes (add the name of the system in next field), Buzzsaw, E-room, Novapoint and others
Sweden	Yes (add the name of the system in next field), Chaos, IDA (project wise), PPi (Sharepoint)
Netherlands	No
Denmark	Yes (add the name of the system in next field), Bentley Project wise + Byggeweb
Finland	No, claudia is near future the procurement portal we have to use. Doesn't accept models, but does accept other digital documents

Country	8.2 What data do you append as part of the tender documents?
UK	Basis data, Drawings
Norway	Basis data, Drawings, 3D-models (models consist basically of 3D-geometry with little information), Set out data/machine control data, Technical specifications for contractors
Sweden	Basis data, Drawings, 3D-models (models consist basically of 3D-geometry with little information), BIM-models (models consist of objects with rich information), Set out data/machine control data, Technical specifications for contractors
Netherlands	Basis data, Drawings, BIM-models (models consist of objects with rich information)
Denmark	Basis data, Drawings, 3D-models (models consist basically of 3D-geometry with little information), Technical specifications for contractors
Finland	Basis data, Drawings, 3D-models (models consist basically of 3D-geometry with little information), BIM-models (models consist of objects with rich information), Technical specifications for contractors, This vary from project to project. Normally we might have quite good models of Bridges but for example road equipment can be cad models and road it self Infra model with some information .

Country	8.3 If answer to 8.1 is Yes, Do consultants/contractors use the same system for delivering data to your organization?
UK	No
Norway	Yes
Sweden	Yes
Netherlands	
Denmark	Yes
Finland	No, they deliver by postal service

Country	8.4 Do you use open standards for the data transfer?
UK	Not sure
Norway	Yes, but in addition owned formats.
Sweden	yes
Netherlands	Yes using ISO/CEN standards and COINS
Denmark	no. supplementary landxml
Finland	Not all but more an more now a days

Country	8.5 Do you specify that documentation should be delivered in open standards
UK	Not sure
Norway	We ask for documentation on open standards and owned formats.
Sweden	yes
Nethelands	Yes
Denmark	DGN
Finland	Yes, depending on structural part we have different requirements for deliverables. But in some cases it is DWG

9. BIM projects

Country	9.1 Who owns the design data?
UK	All phases planned
Norway	NRA
Sweden	the part that supplied the design data claims ownership
Nethelands	NRA
Denmark	NRA
Finland	NRA

Country	9.2 What type of documentation is contractual binding in BIM projects?
UK	
Norway	Models
Sweden	Models
Nethelands	Technical specifications
Denmark	Models
Finland	it depends, at the moment majority is drawings+techical specifications (text) but we are starting to use only models in some cases

Country	9.3 What level of BIM maturity do your organization procure?
UK	Currently level 0 to 1 but planning 2 by 2016
Norway	Level 1
Sweden	Level 2
Nethelands	Level 3
Denmark	Level 2
Finland	Combination of levels :). Depending on what we are doing.

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