The early BIM adoption for a Contracting Authority: standard and methods in the ANAS approach

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ABSTRACT: In recent years, Building Information Modelling (BIM) has contributed to improve the efficiency of Architectural, Engineering and Construction (AEC) sector. In 2014, the European Union issued the 2014/24 EU about the public procurement, where for public work and design contests it is recommended the use of BIM tools.For this reason in 2016, ANAS, the first Italian Contracting Authority for infrastructure projects, decided to introduce the BIM methodology. This paper aims to present the early steps of the research dedicated to the identification of the main activities to set a framework able to provide BIM, in public works. The framework proposed considers BIM as a multi-dimensional system, which starts from the re-engineering of the workflow, the creation of standard, such as the BIM library and then the realization of contract documents for public tenders, such as the Employers Information Requirements (EIR), mean to realize the basis for the spread of BIM.

1 INTRODUCTION

Governments, public infrastructure owners and the society as a whole are facing relevant challenges these days, such as climate changes, resource efficiency, greater demands on social care, urbanization and immigration, an aging infrastructure, the need to stimulate economic growth, as well as constrained budgets. An innovative, competitive and growing construction sector is a crucial component for tackling these challenges.

The European construction sector output of 1.3 trillion represents 9% of EU GDP and it employs 18 million people (European Construction Industry Federation 2017). It is a driver for economic growth and home to 3 million enterprises, most of all are Small and Medium enterprises (SMEs). However, it is one of the last digitalised sector with flat or falling productivity rates (Accenture 2016) . The sectors annual productivity rate has increased by only 1% over the past twenty years (McKinsey Global Institute 2017). Several industry reports (Gerbert, Castagnino, Rothballer, Renz, & Filitz 2016) (The Economist 2015) (National Audit Office 2001) identify systemic issues in the construction process relating to its levels of collaboration, under-investment in technology and Research and Development (R&D) and poor information management. These issues result in poor value for public money and higher financial risk due to unpredictable cost overruns and avoidable project changes. Because of its economic importance, the performance of the construction sector can significantly influence the overall economic development.

Compared to other sectors, the construction ones ,also, is facing its own digital Revolution, having previously benefitted from only modest productivity improvements. Digitization of the construction sector stands for the adoption or increase in the use of digital or computer technology by an entity. It also represents the opportunity for the construction sector to take advantage of the general availability of best practices from other industrial sectors and of engineering methods and tools, digital workflows and technology skills to become an actual digital construction sector.

BIM is being adopted rapidly by different parts of the value chain as a strategic tool to deliver cost savings, productivity and operations efficiencies, improved infrastructure quality and better environmental performance. BIM is defined ”as a modeling technology and associated set of processes to produce, communicate, and analyze building models” (Eastman, Liston, Sacks, & Liston 2008) . The model represents the digital representation of phisycal and functional characteristic of a facility (NIBS 2017) (Chandler, Mcgregor, & Morin 2012) and it contains spatial information, material properties and allows different actors to exchange and update information (Aladag, Demirdögen, & Isk 2016) leading to a better understanding of the whole project.

Governments and public procurers across Europe and around the world are recognizing the value of BIM as a strategic enabler for cost, quality and policy goals. Many of them are taking proactive steps to foster the use of BIM in their construction sectors and public asset delivery and operations to ensure these economic, environmental and social benefits (EUBIM 2017). Consequently, BIM methods and tools implementation represents a relevant challenge for local public contracting authorities, in order to require its use during public tenders.

The purpose of this paper is to describe the early steps of BIM implementation by ANAS SpA, a leader company into the Italian market of design, construction and maintenance of transportation infrastructures, which became, since 2002, a joint-stock company 100%held by Italian Government

2 LITERATURE REVIEW

BIM usage is accelerating rapidly across the globe, driven by the major private and government owners who want to embrace the benefits of faster, certainer project delivery and reliabler quantity and cost (McGrawHill 2014). Whilst the technology enabling BIM emerged in the 1970s and 1980s, BIM implementation has been relatively slow in the construction industry compared to industries such as manufacturing and engineering. Despite this fact, there has been a significant shift over the past ten years as the industry realizes the significant advantages to be gained from the use of this technology (RICS 2013).

A broad range of research is emerging to investigate issues of implementation for the industry (Ahmad, Demian, & Price 2013), and also for the Governments (EUBIM 2017), in order to communicate actual benefits to key players of the construction sector. McGraw Hill (McGrawHill 2014) has produced since 2007 a series of reports which collect global surveys on BIM adoption rates, demonstrating the growing trends of principal markets, till today. Also Dodge Data & Analytics (Fox 2017) has produced market report of BIM adoption, in particular for infrastructure applications, depicting dramatic increases in terms of BIM usage spread, compared to the building sector.

According to McGraw Hill, construction companies have emerged as the leading drivers of BIM innovation and value, in fact, adoption by contractors exceeded architects in North America (74% vs 70%) in 2014, and the percentage is expected to increase in the next few years. The survey was conducted with 727 contractors in ten countries that represent some of the largest construction markets globally; in particular Australia, Brazil, Canada, France, Germany, Japan, New Zealand, South Korea, United Kingdom (UK) and United States (US). A qualitative analysis was conducted also in the two emerging markets of China and India, in order to evaluate BIM engagement in these markets.

Dodge Data & Analytics study in 2017 revealed a bright future for BIM for transportation infrastructures, considering previous studies that was conducted in 2011 where infrastructure was lagging behind the vertical building market in terms of BIM adoption. The survey revealed that BIM users at high level of implementation, especially between engineers, grew from 20% in 2015 to 52% in 2017, among respondents from US, UK, France and Germany. Most of the companies interviewed have found that use of BIM improves their processes and project outcomes most by reducing errors and providing great cost predictability, 87% of users have reported positive value with about half of them reporting a ROI of 25% or more.

Also the EU BIM Task Group, which is a co-funded European Commission project composed by public sector clients, infrastructure owners and policy makers from over 20 countries across Europe, has conducted a survey among European public sector stakeholders (policy officers, public estate, infrastructure owners and public procurers) with the purpose to establish a better understanding of the current status and practices of the member states regarding BIM implementation programs. The study reported that the 69% of respondents have one or more BIM programmes in progress, either at implementation stage, or have executed their programme, mostly under public leadership. Furthermore, the survey explained that public estate stakeholders are primarily focused on economic benefits, while public stakeholders concerned with industrial policy consider more the construction of sector level economic drivers, such as improving the competitiveness and growth of the construction sector.

2.1 *EU Regional trends*

The European Union issued the 2014/24/EU directive on public procurement, recommending to its member states the adoption of BIM in public projects. In fact, art.22, c.4 of the directive reports: "For public works contracts and design contests, Member State may require the use of specific electronic tools, such as building information modelling tools or similar".

Principal EU regional trends and BIM adoption rates will be presented in the following section

2.1.1 *United Kingdom*

In the UK the government has introduced a BIM implementation strategy for the construction industry in 2011, with the ambitious target to require BIM on all centrally procured built assets across all government departments by 2016, through a 5 years stage implementation plan. The plan provided budget and resources to the Construction Industry Council (CIC) to establish the UK BIM Task Group, which defined new ways of working, standards and protocols to help industry in the digital transformation of the sector. The group made freely available the British Standards (BS) and the Publicly Available Specifications (PAS) along with the legal addendum. The next step of the vision provided by the Digital Built Britain is to enable a smart connected high performing built environment, achieving Level 2 of BIM implementation (Gurevich, Sacks, & Shrestha 2017) stage by 2020 and commencing with Level 3 in the same year.

2.1.2 *Finland*

The government entity Senate Properties, responsible for managing the country's property assets, started with BIM pilot projects since 2001. In 2007 they started requiring BIM modelling that is IFC compliant, releasing BIM Guidelines to assist industry transition, updated in 2012 to a National BIM requirement. A strong network of industry parties has been promoted since the beginning, to develop implementation, management and development of common open standards, processes, methods and tools. At the moment, there is no single entity responsible for managing the BIM programme. Some of the future plans of the Finnish Government is to develop more guidelines for stakeholders in BIM based processes and for simulations and analysis. Other initiatives include tools for BIM model uses and model views for maintenance and operation. The InfraBIM standard Inframodel 4 will be finalised and implemented (McAuley, Hore, & West 2012).

2.1.3 *Denmark*

In 2007, Danish government launched the Digital Construction program, following the results obtained from previous studies since 2001. The aim was to define Information and Communication Technologies (ICT) requirements and to promote the use of digital processes, methods and tools among architects, engineers and constructors participating at public tenders. In 2013, the Parliament established a Danish BIM mandate, for all public funded projects over €2.7 million euro.

2.1.4 *Germany*

In December 2015, the Federal Ministry of Transport and Digital Infrastructure (BMVI) launched its strategic Road Map for BIM for the transport infrastructure sector in Germany. This internationally aligned plan, a joint project of government and industry, was largely developed by an industry-led initiative "planen-bauen 4.0" in 2014. It has been designed to facilitate the target that BIM is to be applied on all new public projects procured in Germany from the end of 2020 onwards. A phased mobilization period prior to 2020 is intended to provide a progressive roadmap for the development of capability and capacity in the market, in particular with three levels of maturity.

2.1.5 *France*

The Minister of Housing, Equality of Territories and Rurality presented a plan to revive construction. The Plan de Transition Numrique dans le Btiment (PTNB) is one of three action plans aimed at accelerating the deployment of digital tools across the entire building sector. In its roadmap, PTNB identified the use and promotion of standards as a topic of high importance. The PTNB created a French roadmap in 2015 which provides a three-years timeline. This roadmap is structured around three guidelines, which are related to experiment, capitalise and convince all stakeholders; to support the enhancement of professional skills and stimulate the development of tools tailored to small projects; to develop a trusted digital ecosystem through neutral, stable data formats that can be used in the description of the structures of digital models, tailored for software interoperability and for the development of open source applications.

2.1.6 *Italian market*

Italian Government did not defined a clear vision for a BIM program of adoption, since the publication of the EU Directive 24 in 2014. Before a solid public interest, single firms and groups of associations from the AEC sector such as OICE (Engineering and Economical Consulting Organizations) or ANCE (National Association of Building Constructors), recognised values and benefits of the BIM method and started working with existing software and tools, without any particular existing policy, procurement and legal framework. Most of them using foreign standards and protocols. Anafyo reports (Anafyo 2016) points out in 2015 a business value of €1 billion among private and public sector works related to BIM, and a growing value of €2.6 billion has been reported in 2016 (Anafyo 2017). A first standing proposal came from the Minister of Transportations and Infrastructures with the decree D.Lgs. 18th of April 2016, n.50 which reports: "Public contracting authorities may require [...] the use of specific electronic methods and tools, such as building and infrastructure information modelling tools", along with the national strategy of digitization of the public sector. The strategy adopted by the Italian government to define a BIM program was to establish a Committee (MIT 2016), composed by representing from the academy and governmental departments, with the aim to define progressive times and methods of mandatory adoption of the aforementioned modelling methods and tools.

During the same period, a set of technical national standards and contract protocols have been produced by the UNI (Italian standards Institution) (UNI 2017), in order to develop a compatible regulatory framework to encourage BIM implementation by professionals of the construction sector.

At the end of the ministerial committee's work, a final program of BIM adoption for the public sector was defined with the D.M. 1st of December 2017, n.560. The plan consists in six steps of progressive mandatory requirement of BIM methods and tools for public works, starting from 2019 with works over €100 million cost, until 2025 for works under €1 million cost.

3 METHODOLOGY

3.1 *Case study presentation: ANAS SpA*

ANAS SpA is a public industrial company, leader into the Italian market of design, construction and maintenance of transportation infrastructures and opened to the international market thanks to the subsidiary company ANAS International Enterprise (AIE). It is juridically identified as a 'body governed by public law', which means bodies that are financed, for the most part, by the State, regional or local authorities, or by other bodies governed by public law (**?**). In fact, since 2002 ANAS became a joint-stock company 100% held by the Italian Government. The business plan of investments per year is estimated on €3 billion in works, supplies and services. ANAS owns more than 26 thousands km of roads and highways directly managed and a plan for the renovation of regional and administrative roads of 6 thousands km are already started.

A relevant business plan project started in 2016, related to the implementation of BIM methodology into current practices of design and management of ANAS transportation assets.

ANAS management unit involved into the BIM implementation project is the Design and Works management, and in particular the Design coordination unit is the main responsible. In this unit, there are five main areas of specific development, according to the main disciplines related to infrastructure projects. These specialty fields are represented by i) Infrastructure design and structural engineering; ii) Geology and materials management; iii) Environment, iv) Health and Safety, Expropriations; v) Tunnels and Geotechnics.

Therefore, after the analysis of company process, according to project goals, the early steps of the BIM implementation plan have been related to: i) definition of a roadmap for the introduction of BIM into ANAS; ii) definition of BIM Point of Adoption(PoA) on the basis of the BIM maturity level; iii) creation of a BIM Library suitable for infrastructure project; ii) the development of Employer's Information Requirements (EIRs), in order to enable ANAS to require BIM activities in public tenders.

3.2 *ANAS Project implementation requirements*

ANAS aims to define an appropriate framework able to generate a *new standards for the information management* able to integrate BIM toward different discipline from design to public tenders phases.

Furthermore, taking into consideration a progressive implementation of BIM methodology into the Design coordination unit, how to define by D.M. 560/2017. BIM methodology will mandatory requirement from 1^{ST} January 2019, affecting ANAS' Design and Works unit planned investments, for a 32% of the total in 2019 and for the 89% in 2020.

Therefore, all parts, interested into the project, will get involved in this change of paradigm, not only inside the company but carrying out a key role in the Italian market, encouraging a change of dynamics and behaviors of the construction supply chain, unlock new, more efficient and collaborative ways of working and moreover providing to industry sector requirements and upskill to deliver projects accordingly with applicable standards, guidelines and protocols to "allow them to move forward in a consistent way without distorting the market" (Hooper 2015).

For these reasons, the project implementation requirements are: i) creation of contractual document, for the public tenders; ii) creation of standards and procedures, to manage BIM models; iii) definition of guideline and best practices, for internal and external support.

3.3 *Anas methodological approach*

The methodological approach for BIM implementation into ANAS structure, starts from the definition of some important concepts such BIM maturity stages and BIM fields definition, useful to create a common knowledge for the introduction a roadmap and other oriented activities.

3.3.1 *BIM maturity stages*

In this early stage, it was essential to establish a common definition of BIM, avoiding the confusion due to people perceptions, background and experiences. Therefore, it was necessary to identify the different BIM capabilities on the basis of analytical framework able to describe BIM according to maturity level of end use (Khosrowshahi & Arayici 2012). Additionally, it is necessary to arrange BIM into a framework able to consider BIM not only as separate set of software and process, but especially as the integration of product and modelling process (Succar 2009) (Abdirad 2017) (Hooper 2015).

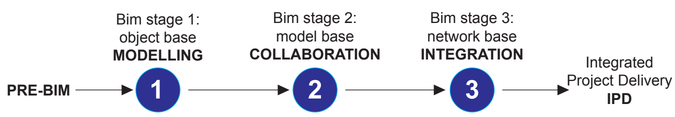


Figure 1: BIM maturity stages

The definition of BIM maturity model is essential in the methodological approach and in the international literature several models were proposed. For instance, according to Succar model (Succar 2009) (Gerbov 2014), as visible in the Figure 1 there are five different moments, starting from *pre-BIM status*, that represent the traditional construction practice, to arrive at the *Integrated Project Delivery* (IPD), that it represents the long term goal of BIM implementation (Smits, van Buiten, & Hartmann 2017) .

Once created a common definition of each stage that compose the BIM capabilities implementation, it is possible to set the goal in short, medium and long term on the basis of investment and process schedule.

3.3.2 *Road map definition*

On the basis of current company and ministerial goals, that ANAS have to achieve by 2019, the road map has been divided in six stages and each of them are essential to achieve an appropriate level of maturity on the basis of ANAS needs, readiness and capabilities, that are:

1. Kick off
2. Imprinting
3. Implementation
4. Analysis
5. Validation
6. Results

The first step *Kick off* aims to create a common base of knowledge about the state of art of *InfraBIM* in the international literature and then mapping the present process in order to implement BIM methodology into public tenders.

The second step *Imprinting* should define what are the models content for each work stage through the study of the international literature of noteworthy publications and pilot projects, in order to identify the best solution for the Italian context.

The third step *Implementation* is focused on the development of BIM model and the creation of a BIM object library for infrastructure project. Furthermore, A EIR template will be produced for design support service.

The fourth step *Analysis* aim to test interoperability process through the use of main exchange data format in order to provide standard information to be shared among different disciplines.

The fifth step is *Validation* of results and calibration of the model. Model calibration and loop of operation for testing the bi-directional process and the capability to maintain the information updated avoiding the lack of data or the recreation of those one.

As visible in the Figure 2, currently the implementation project in ANAS is concluding the preliminary phase, from a *pre-BIM* situation to *Modelling* BIM maturity stage, that refers to the migration from 2D to 3D and object-based modelling and documentation. The BIM model is still single-disciplinary and the deliverable are mostly CAD-like documents, existing contractual relationships and liability issues persist (Succar & Sher 2013).

As mentioned, the infrastructure projects are extremely complex, involving several disciplines at different scales, from regional to construction ones; additionally, there are other important aspects that obstacle the introduction of BIM such as the immaturity of software and interoperability format, lack of contractual documentation, insufficiency of standard and best practices (Bradley, Li, Lark, & Dunn 2016). For this reason, in early BIM adoption it has been essential to define a Point of Adoption (PoA) of BIM methodology, in order to facilitate the process without creating drawbacks to project development.

3.3.3 *Point of Adoption*

According to the roadmap, during the *Kick Off* phase, the current "*as is*" process has been mapped, in order to understand how to manage the progressive introduction of BIM. In this phase, it is essential to define a Technical Adoption Model (TAM) (Ramanayaka & Venkatachalam 2015) (Gurevich, Sacks, & Shrestha 2017) to support the structure to indvidutate an appropriate PoA to overpass the obstacle of this transition from a *pre-BIM* to *Modelling* stage.

The PoA is the point, where after readiness period the organization transforms into organizational capability/maturity, successfully adopting object-based modelling tools and workflows (Succar & Kassem 2015). Therefore, as visible in Figure 3, the PoA has been established at the end of analytic phase, in order to overcome the problems due to the collaboration design, where the interoperability process is not already efficient to allow a real integration of BIM. Despite of the immaturity of BIM application, it should be possible to generate a BIM model, that reports information useful for next work stages.

3.4 *BIM activities*

Once defined the methodological approach, on the basis of the requirements, the roadmap schedule and the PoA. Early steps of adoption were established to operate on multi-dimensional system of knowledge based on a conceptual framework, visible in the Figure 4 composed by three main fields: i) Technology fields is "the application of scientific knowledge for practical purpose"; ii) Process field is "a specific ordering of works activities across time and place, with a beginning, an end, and clearly identified inputs and outputs: a structure for action"; iii) Policy fields are "written

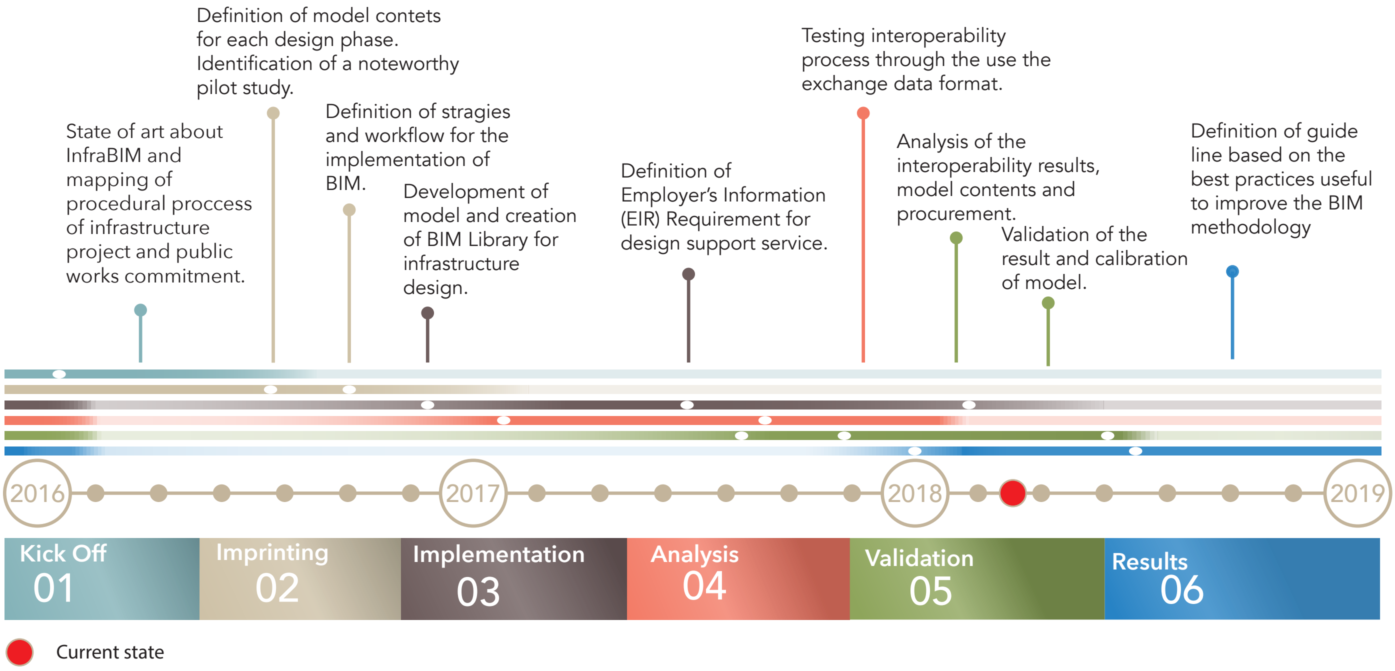


Figure 2: Roadmap for BIM implementation into ANAS SpA

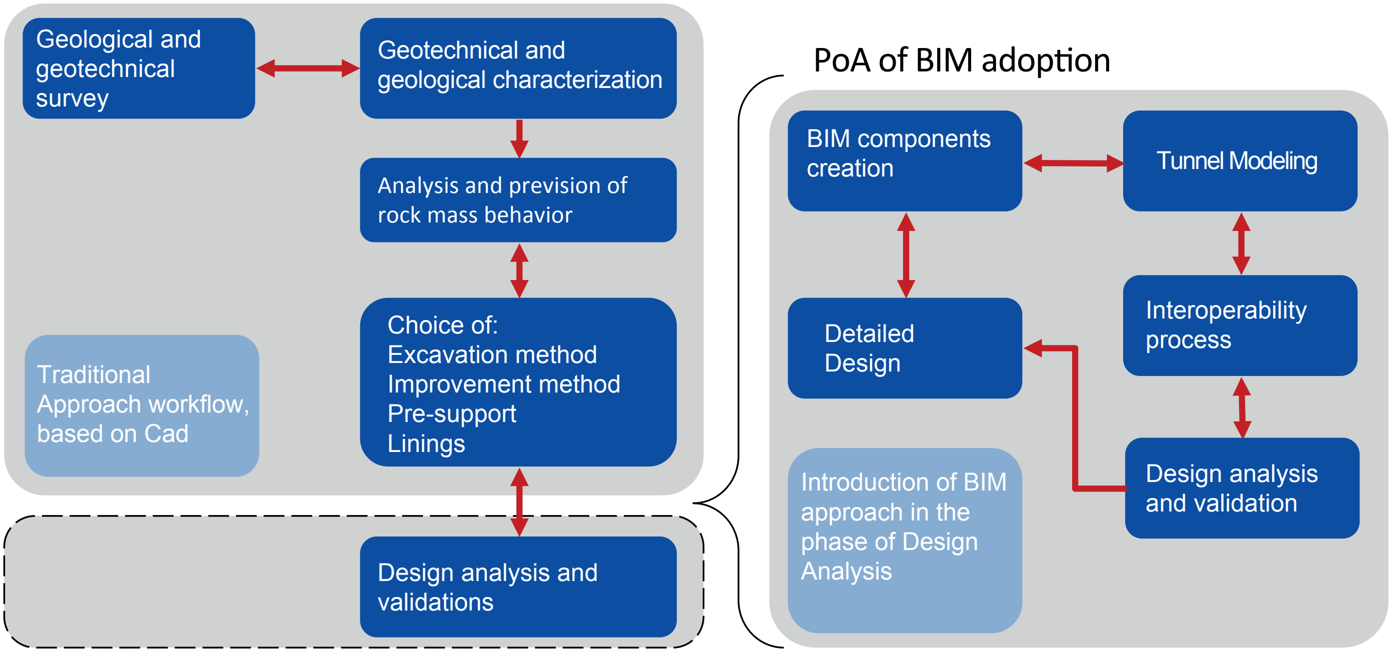


Figure 3: Point of Adoption of BIM methodology in the early steps of projects integration.

principles or rules to guide decision-making"(Succar, Sher, & Williams 2012).

On the basis of the three aforementioned domains, the following activities were developed:

- Re-engineering activities of design process for the *Process field*
- Creation of BIM Library for the *Technology field*
- Development of EIRs for *Policy field*

3.4.1 *Re-engineering process*

The re-engineering activity was dedicated to map internal process for each work stage, in order to understand which information were essential and what are roles and responsibilities as a starting point to define the new system management. In fact, as is visible in the Figure 5, it is important to underline the large amount of disciplines, involved in the design process.

The current workflow is characterized by a unidirectional flow of information, based on CAD application and by a succession of input and output; therefore all information are separated and not integrated, providing, as consequence, the replication of data and difficulty to ensure the information quality and their management for each work stage, without loss of data.

The re-engineering process aims to reconstruct what the outputs needed for the different phases of

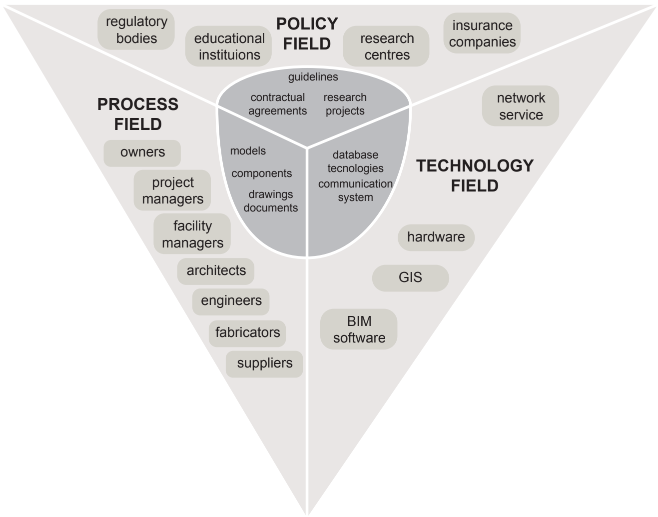


Figure 4: Three interlocking fields of BIM activity

work, which coincide with the documentation needed to pass the authoritarian phase of the government. Introducing a collaborative approach BIM based, as is visible in Figure 6, that expects a sharing of data based on the collaboration of a unique model, where all information are collected and organized. The work flow should provide collaboration, avoiding the lack of data and facilitate the management of information, preserving data available and undated, contributing to avoid errors identifying promptly interference and incongruity.

3.4.2 *BIM library*

Taking into account the insufficient maturity of BIM methodology and tools in infrastructure project, one of the main barrier observed, it is the lack of BIM objects suitable for InfraBIM, useful and usable not only for the geometrical representation but especially for managing the large amount of information.

In this sense, ANAS, starting from a classification of common element, that composed the great amount of its civil works, is going to provide the first BIM library free, multi-platform (Autodesk, Bentley, Archicad, etc.) available for all its service providers.

This strategy presents multiple objectives from different point of view. Primarily, it should promote diffusion of BIM, overcoming the lack of suitable objects in the authoring software. Secondary, it aims to contribute the creation of an ANAS Standard for the development and management of information which derived from the model.

Each BIM object is characterized by geometrical and alphanumerical information, additionally there are several parameters created according to ANAS encoding, as visible in Table 1, to facilitate the operation of verification, validation and then the maintenance. This set of parameter should be able to create a reliable structure of data and standard both for the supplier and the contract authoring, avoiding the risk of redundancy and incongruity of data. Otherwise, it

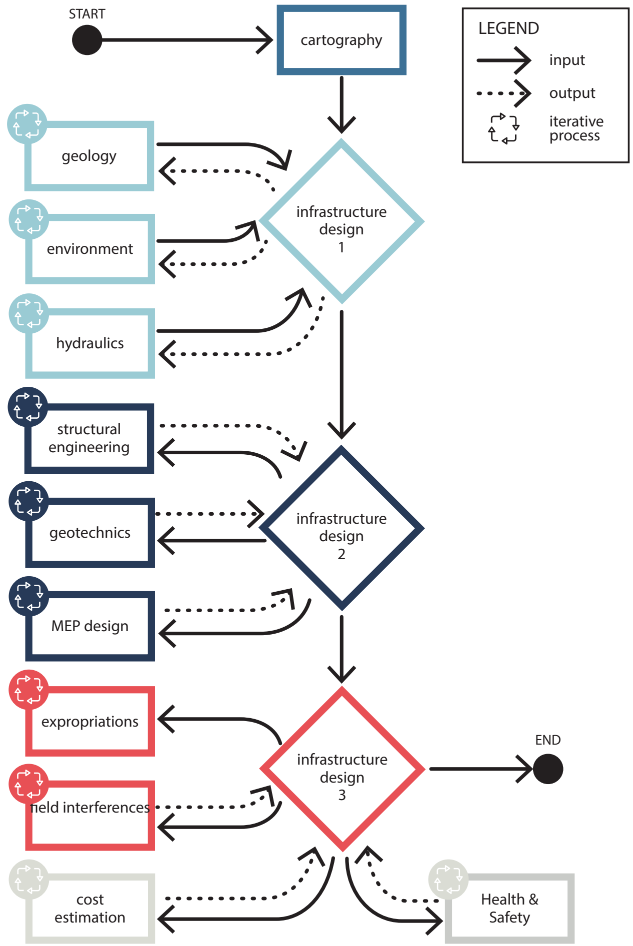


Figure 5: Traditional CAD based workflow

should be impossible to obtain appropriate parametric model able to provide information for each work stage and especially during the maintenance phase.

At the moment, first objects were create for Revit Autodesk, in order to facilitate the estimation of quantity for each part. In fact, as visible in Figure 7 complex element such as the abutment, for instance, are composed by several nested components as ballast wall, retaining wall, winning wall and pedestals. Although this approach could require a great effort for the realization of parametric objects, it should facilitate the connection among model and price list. In this way, it should be possible to account easily work price with the model and also link different kind of information for each phase.

3.4.3 *EIR as a BIM enabler for public tenders*

ANAS priority, as a contracting authority, is to be able to subcontract works, engineering, architecture and support services. For this reason three different technical addendum to contract documents were developed, related to information management of BIM models. Contents of the EIR can be grouped in three main areas: a) technical section, b) management section, and c) commercial section.

Section a) is dedicated to technical specifications essential for the realization of BIM models, such as hardware and software infrastructure, data exchange

Table 1: ANAS parameter identification

Parameter		Parameter description	Parameter type	Disciplin	Data type	Paramenter collection
Codification	A_Progressiva	Codice progressiva	Shared/Instance	Common	Text	Data
Codification	A_Elemento Strutturale	Contrassegno di posizione	Shared/Instance	Common	Text	Data
Codification	A_Codice Pila	ID obejct	Shared/Instance	Common	Text	Data
Estimation	A_Codice Tariffa	Codice tariffa ANAS	Shared/Type	Common	Text	Other
General	A_Parametri sezione	Section Descriptionl	Shared/Type	Structural	Section	Dimension
General	A_Materiale strutturale	Structural material	Shared/Type	Common	Material	Material and finish
Etc.	...	...	...	...	...	...
5						

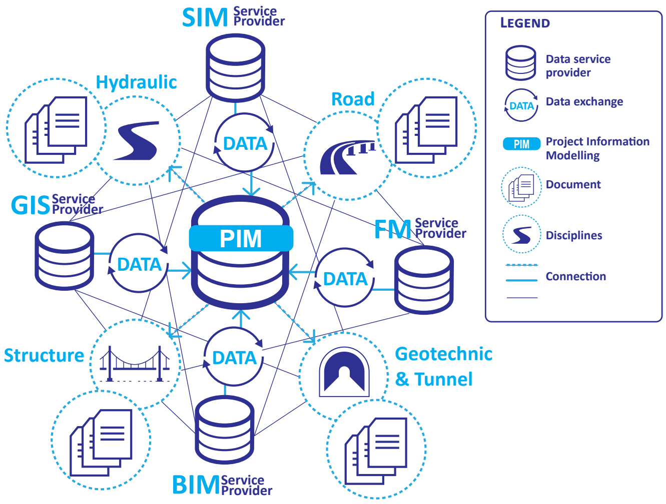


Figure 6: BIM workflow

formats or company standards. Section b) includes requirements concerning information modelling and management processes, such as BIM uses and objectives, level of developments (LODs), or roles and responsibilities. Section c) is related to specific provisions of the service/work, such as model delivery plan, payments or intellectual property.

The first test performed was the development of an EIR for a support service, with the aim to realize the BIM model of a state road, prior to the publication of the aforementioned standards and decrees. In this case, particular attention was dedicated to technical aspects of the services, disregarding a better description of management aspects such as uses and objectives of the model.

The second test performed concerned the realization of an EIR for the update of the previous model during construction works, in order to deliver the as-built of the project. Significant efforts were dedicated in describing standards and classification systems, LOD and special recommendations about required parameters (i.e. object modeler, progressive number of kilometers and geographic coordinates, delivery milestones, reinforcement cover, equipment manufacturer and model, etc.) and also parameters for external references, for the unambiguous identification of documents, images, deliverable directories (i.e. technical sheets, test certification, maintenance plan, etc.).

The third test carried out was the realization of an EIR for a modeling support service of BIM objects, specifically designed for infrastructure projects. In order to avoid unexpected results, a detailed description of BIM uses and objectives has been produced for each object, developing data sheets and providing parameters and information.

The last test performed was about an EIR for engineering and architecture services, developed for ANAS design frame agreements. In this type of contract, the selected contractor or group of contractors are bounded to the contracting authority until the extinction of the total amount of the frame agreement. A very detailed description of technical and managerial aspects has been provided in the document, specifically for validation procedures, time schedule implementation, cost and facility management implementation.

4 RESULTS AND DISCUSSION

According to the estimated time set by D.M. 560/2017, ANAS is continuing the BIM implementation process, establishing a BIM direction appointed to manage BIM models and to provide support at internal structures and suppliers for the creation of parametric model. At the same time, once completed the phase dedicated to process mapping, it is going to define the BIM uses, essential to facilitate the employment of BIM model, during the work stages, because the pilots developed have highlighted that is not enough to indicate the LOD in the contract to ensure an appropriate model.

The first version of BIM library it should be available and uploaded to customers profile in a few month, surely the first of June 2018, because from September ANAS is going to activate the framework, published in October 2017 in which the mandatory use of BIM library has been introduced for the realization of BIM models.

Data resulting from tender respondents are not completely available, but preliminary considerations about EIRs produced during the research can be done. Figure.8 represents the evolution in the strictness of requirements over the four tests performed. A qualitative scale from 0 to 5 has been applied to measure the level of strictness of each content composing the technical, management and commercial sections of EIRs.

The chart points out a progressive increase in strictness of requirements, in particular for the management section. The most increased requirements are i)

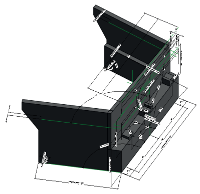
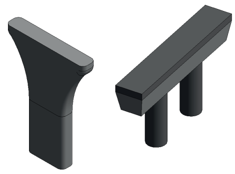
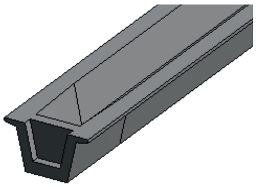
3D Objects	Description	Type	Nested components
	STR_SPALLA: Abutment paremetric model	Strucutural foundation/retaining wall	Ballast wall Retaining wall Wining wall Pedestal
	STR_Pila: Colum parametric model	Strucutural Column	Column Cap Pedestal
	STR_Trave: Beam concret parametric model	Structural beam	Beam
	GET_Fondazione a pozzo: Shaft foundation	Strucutural foundation	Plie footing Pile Steel Rib Filling

Figure 7: BIM infrastructure library

BIM objectives and uses, ii) attended information deliverables, iii) validation procedures and iv) clash and code detection. Data derived from model deliveries of initial tests enabled ANAS to improve following EIRs in critical areas of BIM developments. A minor decrease in LOD requirements must be noticed. In fact, some tests demonstrate a useless contractual value of LODs if not combined with BIM objectives and uses. Furthermore, clear definitions of attended deliverable and validation procedures result in better project outcomes.

5 CONCLUSIONS AND FUTURE WORKS

Early stages of ANAS BIM implementation presented in this work clearly define a preliminary framework of BIM adoption for a contracting authority in transportation infrastructure projects. Solid contract provisions concerning information modelling and management are necessary prior to subcontract services and works. Further investigations are planned for following steps of the research, related to the identification of metrics detailed for contract evaluations, validation procedures of BIM models deliveries, definition of BIM uses for each work and authorization stages.

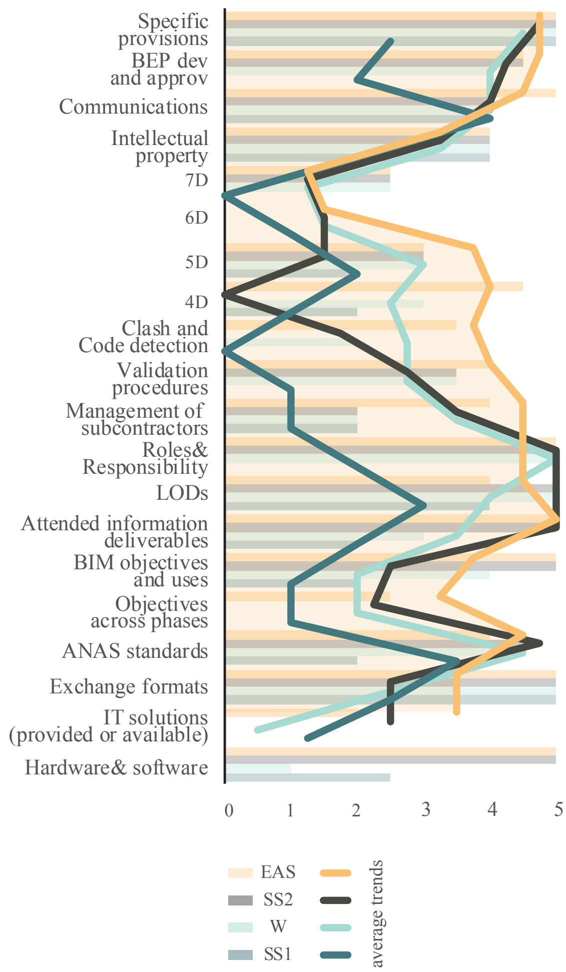


Figure 8: Evolution in strictness of requirements

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