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GUÍAS PROPIAS DE BIM PARA LA GESTIÓN DE PORTFOLIO

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RESUMEN

BIM se está desarrollando en muchos países, pero en su mayoría no es claro cómo y quién debería gestionar su adaptación. El mercado de BIM crece cada día, con un número significativo de cursos de formación y software disponibles, pero aún hace falta definir directrices y procedimientos que permitan orientar a clientes (propietarios e usuarios) a través del complejo proceso de adopción de BIM. Este trabajo pretende mostrar los principales resultados de una investigación realizada por los autores en un caso de estudio para un cliente público italiano que comprende: elaboración de guías, procedimientos, objetos BIM y plantillas para la gestión de una cartera de activos. Las directrices desarrolladas están destinadas a resolver problemas como, por ejemplo, datos faltantes o desactualizados, pérdida de control por parte de los subcontratistas y calculo inexacto de cantidades. Partiendo de una clara definición de los roles y las actividades a realizar, la investigación se concentró en los pasos a seguir para redactar directrices comprensibles dedicadas a construcciones nuevas, edificaciones existentes y al mantenimiento de las mismas. Los resultados de la investigación guiarán al cliente público en su transición desde procedimientos tradicionales a procedimientos basados en BIM. En este documento, se proveen ejemplos con la intención de ejemplificar el uso de directrices específicas, el caso de estudio presentado en este artículo es el asentamiento de la RAI (Emisora pública italiana) en Bologna (Italia), compuesto por el conjunto de cuatro edificaciones utilizados para diferentes propósitos.

Palabras clave: AIM, gestión de activos, BIM, CDE, directrices.

ABSTRACT

BIM is blooming in many Countries but in most of them it is unclear how its adoption can be governed and by whom. The BIM-market is increasing every day, with plenty of training courses and software, but there still is a great lack of guidelines and procedures to take clients (owners and users) through the risky path of BIM adoption. This paper aims to show main results of a case study research carried out by the authors for a public Italian client: development of guidelines, procedures, BIM objects and templates to be used for managing an asset portfolio. The proprietary guidelines developed are meant to solve problems related

to e.g. missing and not updated data, loss of subcontractors' control and inaccurate quantity take-offs. Starting from a clear definition of roles and activities to be done, the research focused on the steps to be taken to write some comprehensive guidelines that deal with new construction, existing buildings and maintenance. The results of the research will guide the public client in his transition from traditional to BIM-based procedures. Examples are provided in this paper aim at exemplifying the use of the proprietary guidelines; the case study presented in this paper is the RAI (Italian public broadcaster) settlement of Bologna, composed by a set of four buildings used for several activities.

Keywords: *AIM, asset management, BIM, CDE, guideline.*

1 INTRODUCTION

Building Information Modelling (BIM) can be considered one of the major and innovative evolutions of processes and instruments in the AEC sector (Architecture, Engineering, Construction); despite the fact that the BIM potential is clear and software are every year more capable, the client has frequently a role very similar to the traditional one, while a step forward is needed to efficiently work with BIM. There are many excellent examples of BIM guidelines to be used by both clients and contractors all over the world (NY and NJ Port Authority [1], PennState University [2], NBIMS [3], etc.), but Italian commissioning bodies, especially public but also private, need to define their own requirements according to the PAS 1192-3:2013 [4]. This activity could take longer than the definition of the bid documents themselves, as it implies the detailed definition of client's needs, to be translated, thanks to the PLQs (Plain Language Questions) into the EIRs (Employer's Information Requirements), to be inserted in the BEP (BIM Execution Plan). Traditionally Italian private clients followed the path made by public commissioning bodies (e.g. for the design and tendering process); so the adoption of a strong BIM strategy from the government would result in the adoption in the private sector. The importance of having a guideline to follow during both daily activities (e.g. space layout changes, components replacement, etc.) and tendering (e.g. construction of a new building) is crucial to be able to set the requirements and then to control the material submitted by contractors (designers, construction companies, FM providers, etc.). Moreover, proprietary guidelines are fundamental for an efficient top down approach of the BIM strategy in an institution: the management is demanded to set the objectives in a plain and comprehensible language, to be translated into BIM-technical instructions by BIM managers and technicians. The relationships among actors and the activities are hence described in the guideline, allowing a robust organisational structural, necessary in BIM-oriented processes.

2 STATE OF THE ART

In this paragraph the latest and guidelines are reported aiming at clarifying the context and the purpose of the research. In Fig 1 some interesting approaches to BIM processes are reported, divided by the main countries all over the world. The references are intended as

examples, as many other interesting documents, both from public and private organisations, can be retrieved. Fig 1 provides a clear view of the BIM adoption panorama. The trend is clearly set and all the major governments are adopting it for their public projects; the same is for relevant private projects, while a great effort should be paid to implement BIM processes at a smaller scale.

At European level, a particular attention is provided by the European directive 23, 24 and 25/2014. They have the aim to increase freedom in the choice of the authorities (i.e. MEAT) [13], but in the meanwhile they are asking more skills empowering them. The European directive 24/2014 aims at: (i) procedural simplification; (ii) reducing fragmentation of the contracting authority; and (iii) estimation of the ratio of qualitative to price. Some of all these future measures will concern BIM, which has been introduced in Italy in the art. 23 c. 13 of D.Lgs. 50/2016 [14]. It has been translated by the Italian legislator with the expression "*methods and electronic instrument, through open format, not proprietary*"; this definition is close to the original one, contained in the Dir. 2014/24/UE, art. 22 c.4. The process is characterised by a strong partnership among the employer and all the suppliers and bidders. In the Italian law (D.Lgs. 50/2016 art. 23 c. 13) BIM is set as a possibility and not as a commitment, based on the fact that Italy do not have an actual law (as the UNI 11337 [18]) and because there are only few people which are trained in this field, even if the situation is changing rapidly.

Country	**Description**
Singapore [5]	The East, as the USA, are characterised by high prefabrication, construction technologies abundantly using steel, tower buildings and construction sites with presence of many more workers than European standards. This adoption of BIM has been also pushed by the need of having higher performance tools to enable building design that until a few years ago would not have been possible.
Finland [6]	As well as Norway and Sweden, it is one of the most advanced European countries in the use of BIM. Here the push to use BIM did not arrive from the government, but from below: companies and designers have wisely adopted this new form of design and management, seeing in it a way to reduce the time, cost and to guarantee a better outcome.
France [7] and Germany [8]	Both governments have invested heavily in 2014 and in 2015 to digitize the building process both for buildings and for infrastructure.
Italy [9]	Maybe Italy started a bit after other European Countries, but it is gaining ground on BIM field; in fact, some public tenders that require BIM design and model set up for operation and management are currently ongoing. Many businesses and engineering companies are upgrading to BIM and also the BIM design became part of the new procurement code.
Spain [10] [11]	The BuildingSMART Spanish chapter made a very broad work, analysing the use of BIM in all the building lifecycle stages; this work is based on the Common BIM requirements 2012 [6]. In addition to this, the es.BIM initiative is actively working for exploiting BIM in the country.
United	Very devoted to the use of BIM, in public, private and infrastructure sectors.

Kingdom [12]	Various ministries (e.g. the Ministry of Justice) have created their own guidelines for use of BIM and the government has decided that from 2016 new public projects are managed in BIM. BIM is very developed in central administrations and national projects, but it still needs to be exploited in local governments, such as rural municipalities.
USA [1]	USA could be considered the inventors of the BIM process, which fits well with prefabricated construction technologies and system engineering, which are the critical aspects of their buildings. They are among the largest creators of guidelines for BIM; among them, it is useful to mention the one of the Port Authority of the states of New York and New Jersey, very detailed and lean.

Fig 1. BIM adoption in major Countries. 2017. Made by the authors.

3 RESEARCH METHODOLOGY

This research lasted almost two years, including literature review and development of procedures, instruments, tools and application to a real case study. The final objective was to create a BIM guideline to be used to manage an existing asset portfolio; together with the guideline, BIM models templates and BIM objects have been produced according to the requirements, with specific sets of attributes and functions to be carried out with linked models (i.e. structural, architectural and MEP). These models have been connected to external databases to better manage historical data about buildings and their components (e.g. documents and maintenance operations). This paper is focused on the contents and application of the guidelines, aiming at describing the principles with which has been developed and the actions that can be governed with it. The development of the guideline can be divided into the following steps: (1) analysis of the requirements of the client; (2) analysis of procedures and workflows currently adopted by the client; (3) analysis of issues and potential of the current strategy; (4) definition of a BIM strategy and new roles; (5) definition of main contents of the guideline; (6) definition of informative and graphical content of objects and model to meet client's objectives; (7) writing of the core parts of the guideline; (8) modelling of objects, models, database creation and testing; (9) writing of the final guideline and annexes documents (EIR, BEP, objects attributes, etc.); and (10) final testing to fine tune procedures and templates. The testing of the guidelines and connected documents has been performed on the RAI settlement of Bologna. This testing has been firstly made by modelling the buildings and inserting the data (documents, pictures, attachments related to the current situation) according to the guidelines and then trying to use the new system and procedures to manage daily asset management activities. The tests have been performed by both high-level managers and facility managers of the settlement. The guideline has been written starting by major existing guidelines all over the world and following the ISO 12911:2012 [15], so to have a guideline tailored to client's needs but also valid at the international level. The next paragraphs contains a detailed description of the guideline, how to use it in recurring asset management activities and some applications to the case study, with the aim of clarifying potential and field of application of the guideline.

4 THE PROPRIETARY BIM GUIDELINE

In this paragraph main contents and features of the guidelines are described, paying also attention to their practical and direct application into asset management activities. The development of a precise and detailed guideline is mandatory for a profitable application of BIM procedures in a company, no matter if private or public, because it sets both the objectives and the ways to achieve them, allowing both bidders to make their work and the company to control their results, achieving the objectives respecting both time and money constraints. In the next paragraphs connections with current standards and best practices, main contents of the guideline and its application to practical workflows is presented, with the aim of explaining how BIM can be fruitfully introduced in a company management process.

4.1 Connections with current standards

The ISO/TS 12911:2012 [15] has been one of the most important references in the development of the guideline, as it specifies how to make a proper BIM commissioning; relevant topics are implementation of repeatable processes, guidance testing and completeness of guidance documents. What comes out from the analysis of the standard is that the more the process is guided and properly explained, the more the output can be controlled; a detailed guideline is mandatory for the BIM implementation into a company. The guideline developed is in between the company and the software related use (Fig 2): it sets macro and sub-objectives, process and sub-processes to achieve them, but also main steps to be carried out in the various software involved in the processes. The document is not a software guidance, but some steps to be followed are critical for the organization and effectiveness of the output and of the process, especially in a complex and large company like RAI (e.g. setting output, even complex, may be not enough for achieving company's objectives). Attributes of the objects and, more in general, data required by the company (in terms of information flows and exchanges) have been organised according to the guidance provided by the ISO 29481-1:2010 [16]. Company's requirements have been divided by stage (e.g. design, construction, operation and maintenance) and the turned into technical specifications to be fulfilled in the Asset Information Model (AIM). The PAS 1192-2 [17], focused on the information delivery, LOD and LOI definition has been a valuable guidance during the definition of the workflows and of the attributes of the BIM objects and models. The PAS 1192-3 [4] helped in the transposition of the asset management processes from plain language to technical requirements; moreover, it had a fundamental role during the definition of the structure of the guideline and of the macro-processes. With these premises, the proprietary BIM guideline developed can be considered compliant with the current international framework; moreover, part of this work has been inserted in the UNI 11337:2017 [18], becoming part of the current national framework.

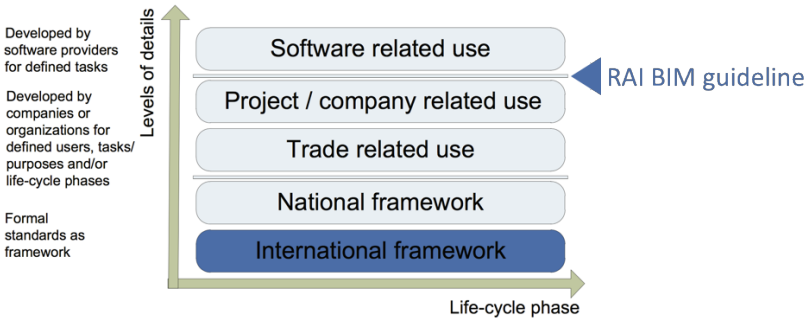

Fig 2. Detail of the guideline developed. 2017. Scheme from ISO/TS 12911:2012 elaborated by authors.

4.2 Contents

The contents structure has been defined according to the best examples and the standards cited above. Here main contents of the guideline are described.

Introduction: this is not only a simple foreword of the guideline, but an important section of the document, in which actors and their workflows are described. The introduction sets the boundaries of the use of the guidelines, together with application purposes and objectives. It describes the path to be followed, using predefined documents and tools.

Denomination: this guideline is demanded to set up and control complex procedures, with consequences on the whole process. The guideline defines a robust process and precise nomenclatures, to be used in the management of documents and in objects/buildings modelling. This chapter includes the denomination of models, documents, disciplines, families, materials, etc. according to the RAI standard: (1) settlement code; (2) building code; (3) storey code; (4) room code; and (5) object code. In this chapter the directory, with its main folders, is defined: 2D drawings, database, families, models and pdf is described. All views, phases, browsers, plans and connected files are defined in terms of nomenclature and relationships among them.

BIM Template: this chapter defines all the key characteristics and features of the BIM templates, divided in architectural (including fire system), structural, mechanical, electrical and master; the last is a coordination template collecting all the other models, linked according to the rules contained in this chapter. Rules about these topic are written: project browser, title block (used to track relevant changes in the model), organisation of levels, grid, views, schedules, rooms, areas and output. This chapter is both a description of the templates but also a guide to produces new ones, compliant with the rules.

BIM library: this chapter contains information about how BIM objects families have been modelled and have to be modelled, in case new objects or types are required. For this first version of the guideline, 197 families have been created; to them, all the families built in the template have to be added (e.g. slabs, walls, roofs). All the objects modelled have been described in specific datasheets that contain all the shared parameters associated to them (name, type/instance, group, unit of measure). Autodesk Revit 2016 has been used in this

process, so the objects may suffer constraints/characteristics due to the BIM authoring software used. This chapter contains the rules to be used in the management of the BIM library. Materials colours have been defined, so to make objects immediately recognisable in the various model views.

Use of the BIM templates: this chapter describes with plenty of details the procedures to use the various templates, modelling buildings and creating digital assets, containing all the data necessary for the management. This chapter contains precise procedures to link the models (e.g. architectural and structural, mechanical and architectural). This chapter is slightly different from current guidelines, as it sets with an high level of detail not only the objectives to be achieved, but also the correct procedures to reach them; this requires a robust definition of both objectives and activities to be carried out by the actors, but it allows the company to control subcontractors, designers and services providers. Then this guideline is forcing people to follow fixed procedures; this has been a matter of great discussion, research and experiments, but it eventually allowed to exploit BIM into RAI current asset management strategy. Setting only the objectives, as can be seen in the case study section, would not allow for a precise control of models and processes, especially during this transition to BIM.

Template DB (database): the databases are associated to the BIM templates and allow to perform activities different but complementary to the ones carried out with the models. Moreover, databases can be fruitfully used by managers, who have great experience and who are demanded to make decisions, but that are not skilled in the use of BIM authoring tools. This chapter contains all the key characteristics and features of the DB templates, divided in architectural (including fire system), mechanical, electrical and master; all the database, except from the master, are linked to the related BIM models. The DB master is linked with all the other databases, but with no BIM model (to avoid duplicated data). This chapter contains also indication about information that has been collected from RAI documents (e.g. maintenance datasheets, contracts, etc.) and then opportunely organised. This chapter describes also the relationships of the databases (relational, made with Microsoft Access), main tables, queries, macros and buttons to automate activities.

Use of the DB templates: this chapter, similarly to the fifth, explains procedures and tools to be used, when and by whom, to use the databases and to manage the data contained in them. The main activities for which they are used are related to the management of: maintenance (input of data about maintenance operations performed associated to objects), documents and spaces. All the procedures described are guided and strongly connected to the objects in the BIM models.

The guideline has been created together with a set of annexes, necessary for its correct use, as well as model and database templates.

LOD and LOI definition. This annex is fundamental for the proper implementation of the BIM strategy in the company and for the correct use of BIM templates and of the guideline in general. This annex defines the Level of Detail (LOD) and the Level of Information (LOI) of all the objects modelled in the BIM library or to be modelled by future designers. This document

allows for controlling the BIM objects, checking the presence of the parameters for the correct implementation of the guideline. Moreover, the annex defines when these data must be filled according to the Italian law [14] and by whom.

EIR (Employer's Information Requirements). The objective of this document is to define the specific objective of the company according to the new BIM processes adopted in the guideline. This template, to be used in case of tendering, contains these chapters: objectives, laws references, procedures, IT characteristics, project characteristics, time and costs validation rules and process management rules. This template has to be filled by the company in case of development of new projects to be assigned to external contractors.

BEP (BIM Execution Plan) template. This document defines the boundaries in which the various actors of the BIM process must operate, share information and deliver the project as requested by the client. The BEP must be submitted by the contractor after the award of the tender and updated during the whole process. This document and the previous one have been fitted to the RAI needs in terms of BIM adoption strategy.

4.3 Operational workflows

The guideline pays great attention to the workflows to be followed by the various actors to make their duties. These workflows have been borrowed from the current practice of the company and then adapted to meet the new BIM-compliant procedures. Moreover, they comply with main standards related to portfolio, asset and facility management [19] [20] [21].The result is a set of defined roles and workflows to be adopted during the operational phase by current managers; the goal in this part was to develop procedures BIM-compliant but also ready to be used by the stakeholders. Creating workflows robust but also comprehensible and readily applicable, with the necessary training, has been one of the leading criteria in the development of this research. In this paragraph some of the workflows defined are briefly presented, also in combination with relevant BIM models and databases involved in the management process.

New construction: objective of this workflow is to guide the creation (design, construction, operation) of a new settlement or of a new building in an existing settlement. This workflow starts with the necessity expressed in plain language by the portfolio manager, transferred into the EIR by the BIM manager; of course this necessity must be approved by the management according to the company's strategy. Designers can then participate to the tender with a pre-contract BEP and then, after the award, they can submit the post-contract BEP and produce the necessary documents and models in accordance with the RAI proprietary guideline and its annexes. So the BIM manager validate the models and the documents submitted and, if no changes are required, deliver the Asset Information Model to the BIM coordinator of the settlement, which is eventually demanded to update the databases connected with the BIM models.

System replacement: objective of this workflow is to guide the replacement of a system (or a relevant part of it) into an existing settlement. The director of the settlement, in accordance with the facility manager, ask for the approval the portfolio manager, which should be

informed in case of important expenses and modifications. Then the workflow is similar to the previous, except for the fact that the BIM model is delivered by the BIM manager to the designers, which have the duty to update the BIM models according to the guidelines. Once the project is ended and validated by the BIM coordinator, the facility manager can update data in the database and provide information and benchmarks to the director of the settlement. Eventually the ordinary maintenance can be carried out, as explained in the next workflow.

Routine maintenance: objective of this workflow is to guide the archiving process of data related to the maintenance operations performed on the buildings and their parts. The maintenance operation is approved or requested by the facility manager, which refers to one or more maintenance operators that are connected to the company (with a global service or other types of contract). The operator performs the maintenance as requested and fills a report. The facility manager validate the documents submitted and updates the database with the information provided. The BIM coordinator exports the data from the databases to the BIM models (with a guided procedure described in the guideline), so to update them.

The central idea behind these workflows is to have always a robust validation of the information and of the models provided by actors external to the company. The second idea is to have a robust hierarchy that links the BIM manager, at portfolio level, and the BIM coordinators at the settlements level, so to have always updated, reliable and univocal data. These workflows have been tested and validated by the company; some examples are provided in the next chapter.

5 CASE STUDY

The BIM guideline has been applied to the settlement of Bologna, made of four buildings with different function, for a total of 15'000 m^2 of gross floor area. This settlement is representative of the RAI Italian portfolio, so it has been considered a suitable case study for the validation of the guideline. In the next paragraphs two examples of application are presented, with the aim of showing the guideline and its main features.

5.1 Settlement description

The settlement consists of four existing buildings (Fig 3): the main one contains mainly offices, direction and production rooms (TV and radio studios, offices, canteen, underground parking, etc.), while the others contain respectively the entrance (which is regulated for security issues), services rooms, mechanic's workshop and garage. The masterplan has been made linking together all the models, divided by discipline (architecture, structure, systems) and by building; the main purpose of this model is coordination and visualisation, while management (e.g. maintenance operations data storage, documents management, space management, etc.) is carried out in the single BIM models and databases. While the three ancillary buildings are quite simple in terms of shapes and technologies, the main building has five storeys and a complex infill, with a mixture of different technologies and finishing, mainly due to the modifications occurred over the years. This complexity, initially

perceived as an obstacle in the modelling phase, helped for the creation of a robust coding system able to define spaces and technologies, being eventually able to manage all the finishing in connection to spaces and zones of the building.

The building has been surveyed to update and correct the as-built and design drawings provided by the client; only minor changes to the model (respect to the drawings provided) have been performed as all the main components where in the correct position. On the opposite, a detailed survey has been performed to gather all the different finishing of each space (floors, walls, ceiling), with more than one hundred of types. Great attention has been paid to structures, which have been modelled as a stand-alone BIM model, linked to the architectural one; structural drawings where up-to-date and no modification has been necessary. Regarding the systems, as-built drawings and layouts have been used to locate and model main components (e.g. heat generators, fan coils, plugs, air terminals, etc.); a detailed survey has been performed to validate number and type of light bulbs. The models contain totally more than 33'000 objects over the settlement. For this first case study, ducts, piping and circuits have not been modelled, as not surveyed. The survey has been conducted with the rules written in the guideline, which have been also updated with feedbacks from both RAI asset management team and the professionals demanded to create the BIM models. The models have been eventually set up with all the attributes described in the guideline and in the attached document related to LOD and LOI definition.

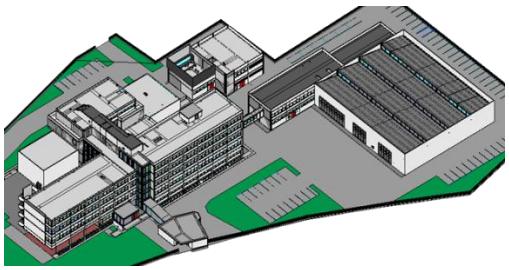

Fig 3. BIM masterplan of the settlement. 2017. Made by the authors.

5.2 Existing buildings

Existing buildings, especially offices, frequently need to be modified, to meet higher standards or client's requirements. The guideline has been set up to regulate the information exchange, as instance, in case of internal layout modification.

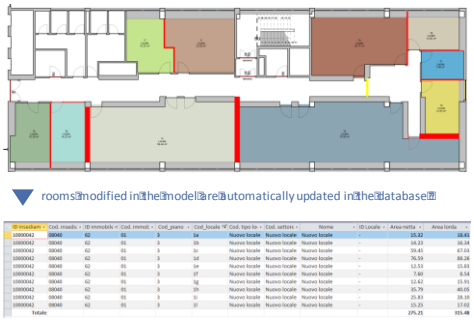

Fig 4. Comparison plan in case of layout modification. 2017. Made by the authors.

In this brief example, main steps of the process are reported, aiming at showing potentials and criticalities of the guideline. A change in the offices layout (internal walls, systems and rooms surface) has been simulated to test procedures, workflows and instruments developed. Here an extract of the comparison plan (demolition and new construction) is presented (Fig 4). The workflow allowed the client to express his need, the designer to modify the model (adding a new phase) and eventually the facility manager to update data about systems and surfaces. At the portfolio level, spaces naming, areas and functions have been updated. All the data were consistent and updated in all the phases.

5.3 Ordinary maintenance

In this example some maintenance operations are performed on one of the two heat generators. Thanks to the instruments developed, the maintenance operator, after the operation, has been able to enter the summary data and to associate them to the object in the mechanical BIM model. The attribute “last maintenance performed” on the heat generator has been also automatically updated. In the Fig 5 an extract of the maintenance sheet (left) and the updated BIM object (right) is presented.

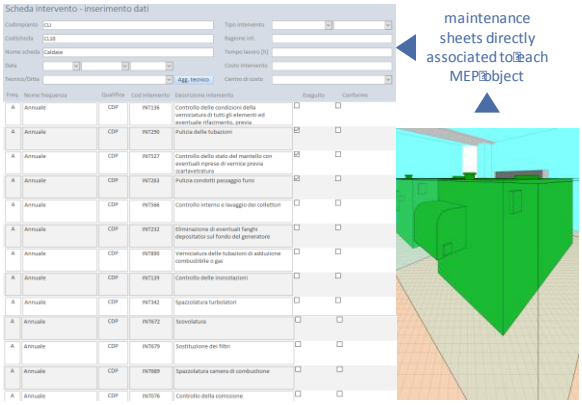

Fig 5. Maintenance operations data entry. 2017. Made by the authors.

This procedure, fully described in the guideline, helps in dealing with information during the settlement management. The data can be further elaborated to benchmark the behaviour of services providers and components failure rates, so to improve the settlement operation and cut operational costs.

6 DISCUSSION AND CONCLUSIONS

BIM processes are a mandatory step for the development of the AEC sector; nevertheless, more than software, BIM-oriented strategies are needed. This guideline aims at filling the gap between operators and managers, allowing the latter for a better asset and portfolio management strategy. The guideline developed can be considered an innovation of the current state of the art as it states not only input and output (e.g. plans, bill of quantities), but also defines precise actors and workflows to be followed, allowing the client to control operators’ work. This is relevant in the current panorama, characterised by a great

uncertainty of the roles and of the procedures to be adopted. This guideline clarifies both strategy, at high level, and objectives, at middle and low levels, supporting activities and interactions among actors. Authors planned to revise and improve the guideline with feedbacks coming from the client, which is currently using it; moreover, additional procedures, related to the management of construction sites (to deliver as-built BIM models) are currently in the development phase. The Italian government, once set is strategy on digitisation of the construction process according to D.Lgs. 50/2016 art. 23 c. 13 [14] (currently is just an indication), will be probably asking for interoperable formats to make the process more standardised; this guideline could be then adapted to these requirements, including as instance the use of IFC models to store and exchange data (allowing different BIM authoring software) but for now, the goal was delivering a set of procedures and tools ready to be implemented in the current asset management process of the company. Moreover, processes, workflows and data described in the guideline can fit into an interoperable process, as it will be requested by the government, as they are not connected to a specific tool.

7 AKNOWLEDGEMENTS

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