The STREAMER European Project. Case Study: Careggi Hospital in Florence

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Abstract— **In this paper is shown the European research project STREAMER in the topic "Optimised design methodologies for energy efficient buildings integrated in the neighborhood energy systems". The Streamer research project aims at use and development of a semantic approach to design starting from the combination of BIM and GIS systems. A case study in Careggi hospital, Florence (Italy) is shown, together with the expected results**

Keywords— **STREAMER, Energy efficiency, Hospital analysis.**

I. INTRODUCTION

The European Union (EU) considers the energetic efficiency for hospitals as one of the most urgent and prominent research topics [1]. STREAMER is a research project co-founded by the EU in the topic "Optimised design methodologies for energy efficient buildings integrated in the neighborhood energy systems" of the Framework Program 7th (FP7). The project, started in September 2013, has a quadrennial duration and involves twenty partners from nine different EU countries. The final goal of the research is the reduction by 50% of the overall energetic consumption and carbon dioxide pollutions for big healthcare structures undergoing renovation processes. These results will also be achieved by designing and realizing advanced Information and Communication Technologies (ICT) tools such as Geographic Information Systems (GIS) and Building Information Modeling (BIM) systems.

A hospital consumes, on average, from two to five times more than an office building. In Europe there are about 15.000 hospitals that are responsible for at least 5% of the overall European annual emission of carbon dioxide (equivalent to 250 million tons). Healthcare generates about 10% of the Gross Domestic Product and a hospital can burden for up to 60% on the total expenditure of a country. [2][3][4]

The critical point in the search for energy efficiency in health structures is the inadequacy of the available methods of project planning, especially with regard to context-aware holistic solutions. Three are the main challenges to face [5][6][7]:

- Lack of holistic approach that is able to deal with the complexity typical of these complex multidimensional healthcare structures.
- No optimization between the different levels, for example between technological components, building and environment.
- Usually the design process begins with an ad hoc survey for problems and solutions. Many changes are often necessary during the design phase that usually takes years before reaching the implementation phase [8].

The design is always about sizes and different scales: an effective new design method should be based on interoperability between Building Information Modeling (BIM) and Geospatial Information Systems (GIS) [9][10]. For example, the optimization of energy efficiency can only be achieved with a proper relationship between architectural system and plant system through the Modeling Product Lifecycle (PLM) systems and Building Managment Systems (MBS) connected to BIM and GIS . The new method should cover all levels and phases of the lyfe cycle for the built structure, as well as the entire life cycle of the modeling itself: BIM, Building Assembly Model (BAM), Building Energy Model (BEM) and Building Operations Optimization Model (BOOM).
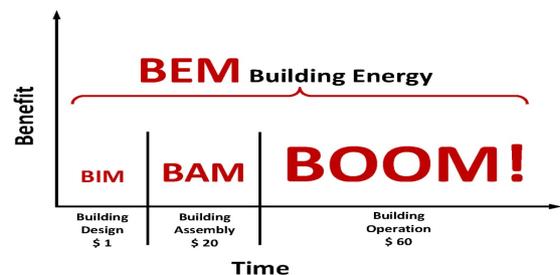

Fig. 1 Modeling levels (source: Streamer research program; adapted from [11])

The European research project Streamer (7th Framework Programme) relates to all this. The project involves a very large consortium of industrial and research partners and takes advantage of the use of case studies of health districts (mixed use) present in 4 different countries. A health district is a very significant example of neighborhood, with an integrated energy system, which consists of various buildings (hospitals and clinics, university buildings and research, guest quarters, facilities for rehabilitation and sports, offices, shops, central technological , etc.).

II. MATERIALS AND METHODS

The Streamer research project aims at use and development of a semantic approach to design starting from the combination of BIM and GIS systems. The semantic design, in this context, is defined as a method of participatory planning that is based on rational performance analysis of those models that integrate design requirements, interpretations and knowledge coming from design team, stakeholders and users. It is a methodology that is based, of course, on the knowledge of technology and products, but also on the "implicit" of human knowledge and on empirical data about the building's functioning. [12][13][8]

The use of BIM switches from the current usage as a tool for designing and printing (3D modeling, animation, databases, spreadsheets, and drawings in 2D) to a coordinated and cooperative working procedure in which the data processing functions are maximized and are based on an integrated computer model [14].

The project operates on two areas of innovation and it develops research in 4 stages. The two areas are:

• *Technological innovation*: energy efficiency is optimized by the typological point of view (building and district) and from the technological point of view
• *Semantic design innovation*: energy efficiency is pursued by working with new methods and tools that facilitate the collaboration of all the actors involved in the process.

The 4 work phases of work are: A) Conceptualization; B) Configuration; C) Optimization; D) Generalization. The study is divided into 10 work packages of which 6 are of Research and Technological Development (RTD).

The research consortium consists of 20 partners (construction companies, engineering companies, medical institutions, research institutions and government agencies) that provide high quality design and an equally large impact of results at Europe.

In the research group are represented 3 sectors that are essential to ensure the development, optimization, validation and use of new design methods for energy efficiency:

- engineering and environmental design with particular expertise in the field of urban design and sustainable buildings;
- buildings construction, maintenance and management, including energy, with particular expertise in the user-oriented design and management;
- research and development of energy systems of buildings and urban neighborhoods with particular experience in the field of plant buildings, energy urban infrastructures and renewable energy resources;
- research and development of Information and Communication Technology (ICT) advanced design procedures with particular experience in the field of BIM, GIS, semantic web, parametric modeling, ontology, Product Lifecycle Management (PLM) and related open standards (IFC and CityGML) ;
- Public policies and business strategies of buildings' energy efficiency, aimed at the management and sustainable transformation of the public health heritage.

The research results will be verified through their application during the design phase of new buildings or buildings to be redeveloped in 4 health districts that, by typology, size and function, are truly representative of those found in Europe: large hospitals included in health-containing mixed-use neighborhoods:

- NHS, Rotherham, UK
- Rijnstate Ziekenhuis, Arnhem, Holland
- AOUC, Firenze, Italy
- AP-HP, Paris, France

III. EXPECTED RESULTS

The research project is still at an early stage, exploratory, but the expected results are clearly identifiable in:

1) the definition of semantic typological models (BIM and GIS) as a reference for the new construction and renovation of energy efficient buildings included in health districts;
2) the definition of a framework for the BEM that connects the model related to the planning phase with those produced during the construction and operational phases, throughout the building life cycle;
3) the creation of a decision-making tool that contains: BIM models and GIS design, project performance evaluation and analysis of the needs and

priorities for all the stakeholders during all the process stages.

The main challenge is to solve the interoperability and dialogue problems between the available, but very dissimilar, tools for design, modeling and management. In addition, there are different levels of detail (LOD) for these models, that the need to work across platforms and open-source solutions for a wider and more efficient use of the new Streamer tool.

Gradually, and for the entire four years duration of the research, these findings need to be verified and validated on 4 case studies, both from a strategic/theoretical point of view and from a technical/operative point of view.

In order to assure the theoretical validity of the results, the research program includes the organization of workshops or sessions:

- Semantic design
- Planning and coordination
- Users involvement (patients, doctors, executives, etc.)
- Energy performance simulations.

To guarantee the practical validity of the results, the program includes:

- selection of a portion of the actual strategic plan in the health district, to be used for research purposes;
- verification and validation of the models that come from the semantic transformation of existing projects in the district, taking into account the conversion of regulatory standards and the needs and knowledge of the administrator;
- verification of interdisciplinarity and disposition to implementation of the new instrument.

The AOU Careggi, in particular, is required to focus the research on aspects related to the electricity and steam distribution as well as to the optimization of functions between the buildings.

The Company has, in the context of the research program, the possibility of using its effective tool for monitoring and management of healthcare structures, the SACS$^©$, the result of the ten years collaboration with the University of Florence [Figure 2]. For a detailed description of SACS$^©$, please refer to [15][16][17][18][19].

Fig. 2 The SACS$^©$ system

The most recent development has focused on the system geo-referencing.

Using open source software for the management of geo referenced maps (QGIS), was created a geo-referenced map, containing all the data of the 74 acres that make up the Careggi hospital. Cartography, using the bases of CTR (Regional Technical Map) at the scale of 1:2000, was geo-referenced using the "Montemario" reference system.

The information managed by the GIS support, namely CareGIS, are accessible from the company intranet, contain information about the logistical tunnels and technological networks and types of main plant. The system manages both qualitative and quantitative parameters such as lengths, correlations, etc.

Six months after the Streamer research start, considering the planning of future interventions on the estate, the AOUC has chosen to use the oncology center named "San Luca" as the case study for validating the research results. The center consists of a complex of three buildings. The first of the three buildings, the "Old San Luca", was built in the 60s on three levels.

The AOUC top management, considering the age and inefficiency – from a functional and a performance point of view - has raised the problem of the type of intervention to be undertaken, whether to make a demolition/reconstruction or a deep restructuring.

Streamer, therefore, becomes a strategic tool to make this choice based on energy efficiency criteria. To build up the tool it is firstly necessary the BIM and GIS modeling of the entire health district, and then the modeling of the three

buildings that constitute the oncology center, according to different levels of detail.

Thanks to the availability of data and plans contained in the SACS© database, a first model has already been developed and delivered to the University of Karlsruhe German partners that have turned it into a geo-referenced BIM with LoD2 Multisurface (fig. 3).
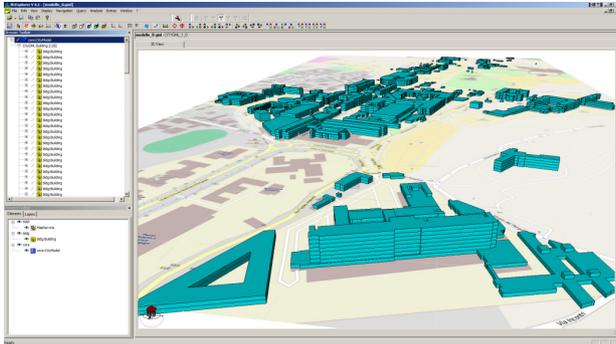

Fig. 3   The geo-referenced BIM model of Careggi (source: Karl-Heinz Haefele)

The next stage, just begun, is about the preparation of the three-dimensional model with LoD3 of the three buildings that constitute the cancer center, to be used as the basis for the implementation of BIM, by the Dutch colleagues. The goal is to be able shape, with the greatest detail, a group of 4 rooms within the "Old San Luca".

ACKNOWLEDGMENT

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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