POLITECNICO DI TORINO

Honors thesis

Master course (LM-4)

Architecture for sustainable design

Abstract

Energy assessment and Multi-Criteria decision analysis to identify retrofit strategies within university campuses: application to the PoliTo case study

<table>
<tr><td>*Tutor*</td><td>*by*</td></tr>
<tr><td>Stefano Paolo Corgnati
Marta Carla Bottero
Cristina Becchio</td><td>Cecilia Ciccarelli</td></tr>
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The goal of this thesis is the evaluation of eight retrofit scenarios (alternatives), according to four areas of competence (criteria): environmental, economic, technical and social. These scenarios results from the composition of eight retrofit strategies suggested in the ISCN-GULF **[17]** report, belonging to "Energy and buildings" dimension. The ultimate purpose is the ranking of the alternatives, following the subjective judgement of four experts, in order to identify an intervention priority.

The analysis of this thesis and the identification of alternatives rankings was conducted, performing two assessment;

• *Energy assessment:* through Simplified Energy Audit Software (SEAS), to evaluate consumptions (electricity and district heating)

• *Socio economic assessment:* through a Multi-Criteria Decision Analysis (MCDA), to evaluate benefits generated, in particular nine, according to four areas of competence.

These two analyses set the aim to quantify the advantages that Politecnico could acquire in investing in some technologies / initiatives (retrofit strategies) proposed in the report.

Firstly, a building's diagnosis is performed constructing a model in SEAS (pre-intervention) in order to identify the current energy consumptions (electricity and district heating).

Secondly, the retrofit strategies are tested in the software, carrying out a simulation, useful to detect energy consumptions post-intervention and primary energy savings that repre sent part of the evaluation of the MCDA assessment.

Thirdly a socio-economic assessment is performed, through a Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) assessment. Eight scenarios are evaluated, accomplishing objective measurement with value judgement. The assessment helps to manage subjectivity and the related weights assigned to criteria and sub-criteria.

With this purpose, the building, dealt within the thesis, is the Politecnico headquarter in Corso Duca degli Abruzzi, made up of five smaller buildings.

This thesis wants to identify rankings, in order to give back to PoliTo different ways of intervention, supported by criteria adherence.

The strategies to evaluate in this thesis, from ISCN report, are:

• *EB_1: Increase electricity products by Renewable Energy Sources (RES)*

• *EB_2: PoliTO project "PoliSAVE"*

• *EB_4: Substitution of old lamps with LED*

• *EB_5: Heat supply from IREN district heating for DHW*

• *EB_6: Promotion and management of a "water dispenser"*

• *EB_9: Replacement of all windows-frame antiquated with new typologies*

• *EB_12: Awareness campaigns about energy savings "M'illumino di meno"*

- *EB_13: Temperature variation in winter period, from 20 °C to 19 °C*

The first step, in the chapter 4, is the data collection of the building case study, CAD architectural designs and technical data about geometry and envelope.

The second step, in the same chapter, is the energy simulation of the building through an energy model construction in SEAS.

The third step, in the chapter 5, is the presentation of the retrofit strategies to investigate.

The fourth step, in chapter 6, is the MCDA analysis, through TOPSIS that begins with the presentation of the retrofit strategies and criteria to lead the analysis and identify a ranking.

The fifth step, in chapter 7, is the MCDA of eight alternatives, resultant from the composition of three retrofit strategies at a time. The criteria used to evaluate the alternatives belong to four areas of competence: environmental, economic, technical, social and, are divided into sub-criteriaTwo kinds of rankings are the final results of this thesis; the first takes into account the retrofit strategies; the second that takes into account the alternatives. The most surprising result is the persistance in the second ranking, as ideal solution, of the same alternative. The best alternative provides the composition between these three measures: *EB_4: Substitution of old lamps with LED, EB_9: Replacement of all windows-frame antiquated with new typologies, EB_13: Temperature variation in winter period, from 20 °C to 19 °C.*

This settlement is made up of two initiatives that produce relevant energy savings, even though they require high efforts in terms of investmentcosts. This result is due to their predominant decreases in primary energy consumptions and important savings in terms of costs and in the period of utilisation.

Future developments could be the implementation of MCDA through TOPSIS to assess the other retrofit strategies detected from the other dimension that PoliTo wants to pursue.

For further information please contact:
Cecilia Ciccarelli, ciccarelli.cecilia@gmail.com