

**KEYWORDS**

maintenance, comfort and salubrity, data analysis, environmental cost

**GOAL : HOW IMPROVE THE PERFORMANCES OF THE EXISTING BUILDING STOCK IN BELGIUM ?**

**INTRODUCTION / LITERATURE REVIEW**

- ▶ The increasing of housing renovation rate to 3% is crucial [1] to decrease Belgium GHGE by 80% [2] and meet its international commitments.
- ▶ This increasing would also lead to numerous side effects [3], such as
- ▶ It is difficult to rank the effectiveness of the various measures undertaken over the past 20 years [4], while no study has looked at the statistical evaluation of their impact.
- ▶ This study therefore proposes to use the available databases to discriminate and model through a top-down approach the effect of different Influencing Factors on several Evaluation Criterias.

**HYPOTHESIS**



▶ Fig. 1 Hypothesis of a model explaining the impact of different influencing factors on several evaluation criteria for the performance of the built stock. (Ruellan, 2018)

**OBJECTIVES**

- Define the Evaluation Criterias (EC) of the performance of the existing building stock in Belgium, using a top-down approach.
- Suggest Influencing Factors (IF) that could impact and improve the performance of these Evaluation Criterias.
- Find data to quantify these Evaluation Criterias and Influencing Factors in Belgium between 2000 and 2015.
- Develop a function of correlation between these Influencing Factors and the Evaluation Criterias through statistical analysis of the collected data.
- Validate or correct this function by analyzing a case study.

**METHODOLOGY (FIG. 6)**

**▶ DEFINE EVALUATION CRITERIA AND INFLUENCING FACTORS**

The Evaluation Criterias (EC) are what enable us to define the success criteria for a sustainable renovation policy whose success does not depend solely on the energy savings generated (see below for more information).

Influencing Factors (IF) are all factors that directly affect the renovation rate of existing built stock and/or the building's energy consumption (see below for more information).

**▶ QUANTIFY EC AND IF**

The population is considered to be the years 2000 to 2015.

Based on a previous study [5] and available data, are currently used as EC :

- number of permits to renovate (STATBEL) (Fig. 4);
- energy consumption of the housing sector per person (EUROSTAT) (Fig. 5);
- energy poverty (EUROSTAT).

Based on a previous study [5] and available data, we currently retain as IF :

- Belgian population (STATBEL);
- heating degree days (EUROSTAT) (Fig. 3);
- energy prices (EUROSTAT);
- U-values regulation (Fig. 2);
- selling price index for existing homes (EUROSTAT).

**▶ ANALYZE EC AND IF**

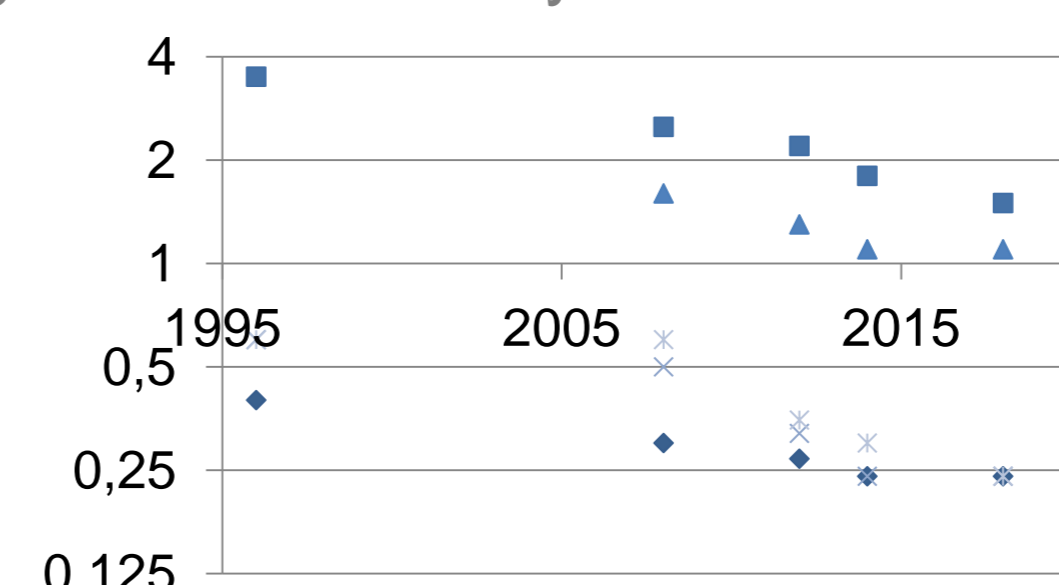
A descriptive part of the statistical analysis itself allows, through a covariance calculation, to identify the most relevant variables. This first phase can possibly be extended by the search for new, more relevant variables. A Principal Component Analysis (PCA) should simplify the variables studied to focus on the main effects.

**▶ CORRELATE EC TO IF, THROUGH A F FUNCTION**

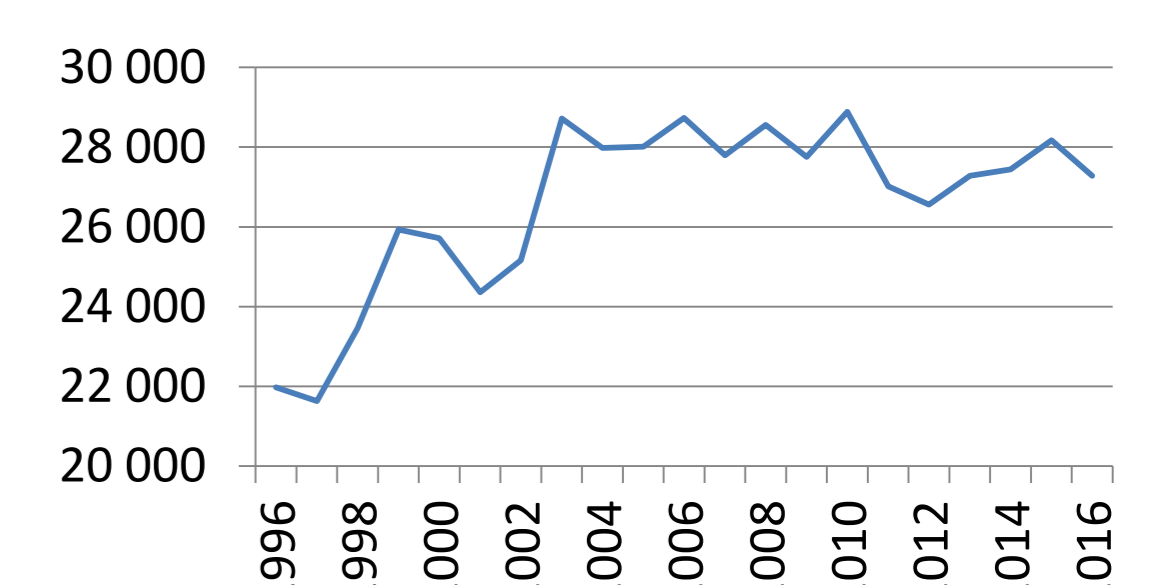
The inferential part of the statistical analysis then leads to the definition of a correlation function making it possible to propose a probabilistic model of the evolution of the EC according to the modifications intervening on the IF.

**▶ VALIDATE F**

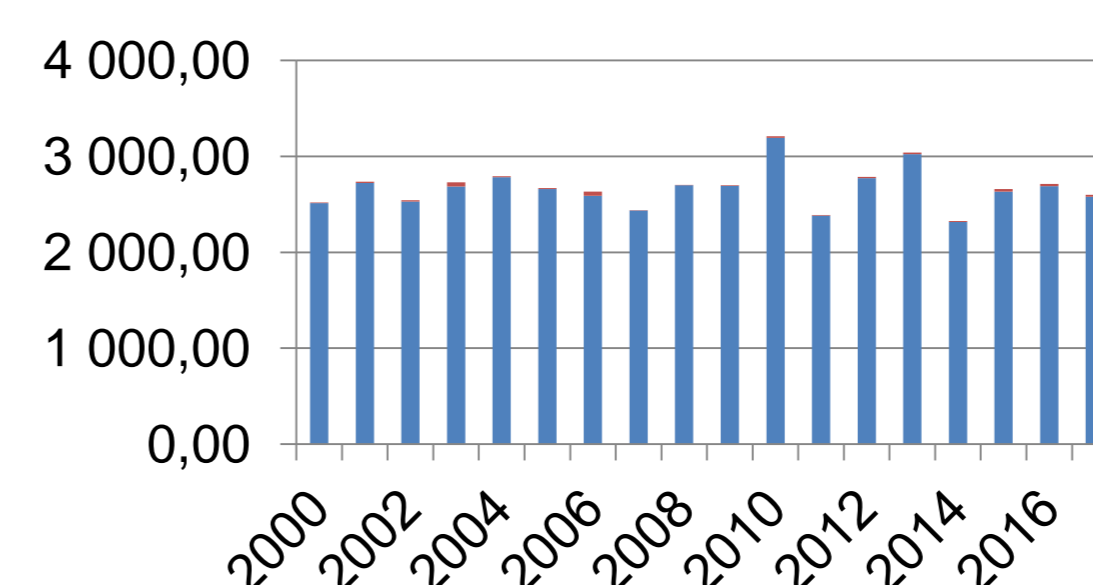
The use of standardized analysis methods makes it possible to obtain indicators throughout the process that can ultimately estimate the accuracy of the reasoning. This validation of the F function will be coupled with the analysis of a test case based on a different population (time interval).



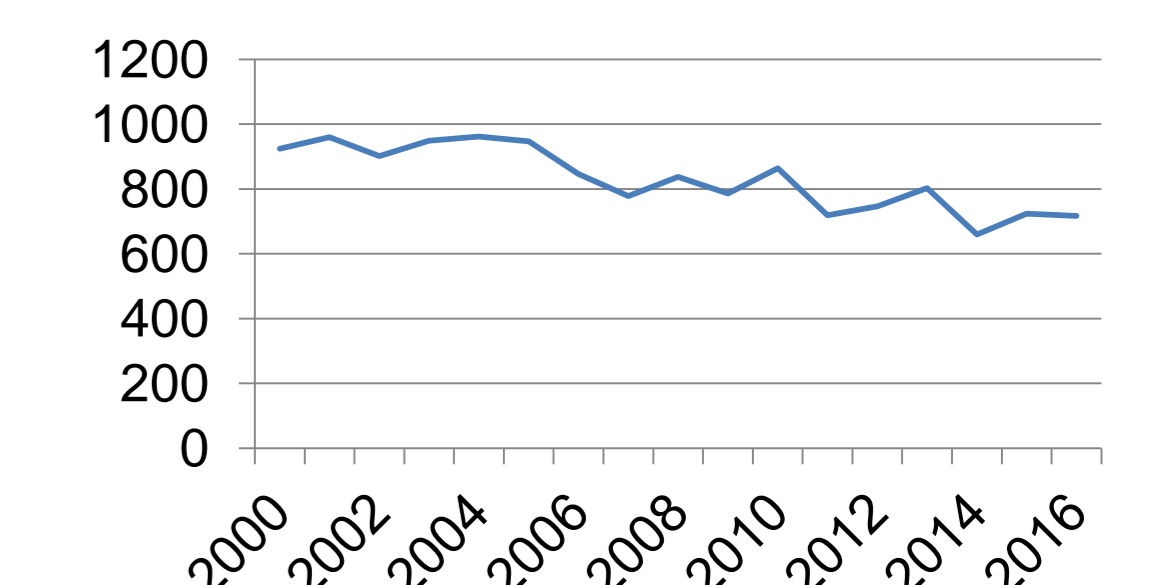
▶ Fig. 2 Umax (W/m²K) regulation (roof, windows, wall and floor) for Walloon region (DGO4, 2017)



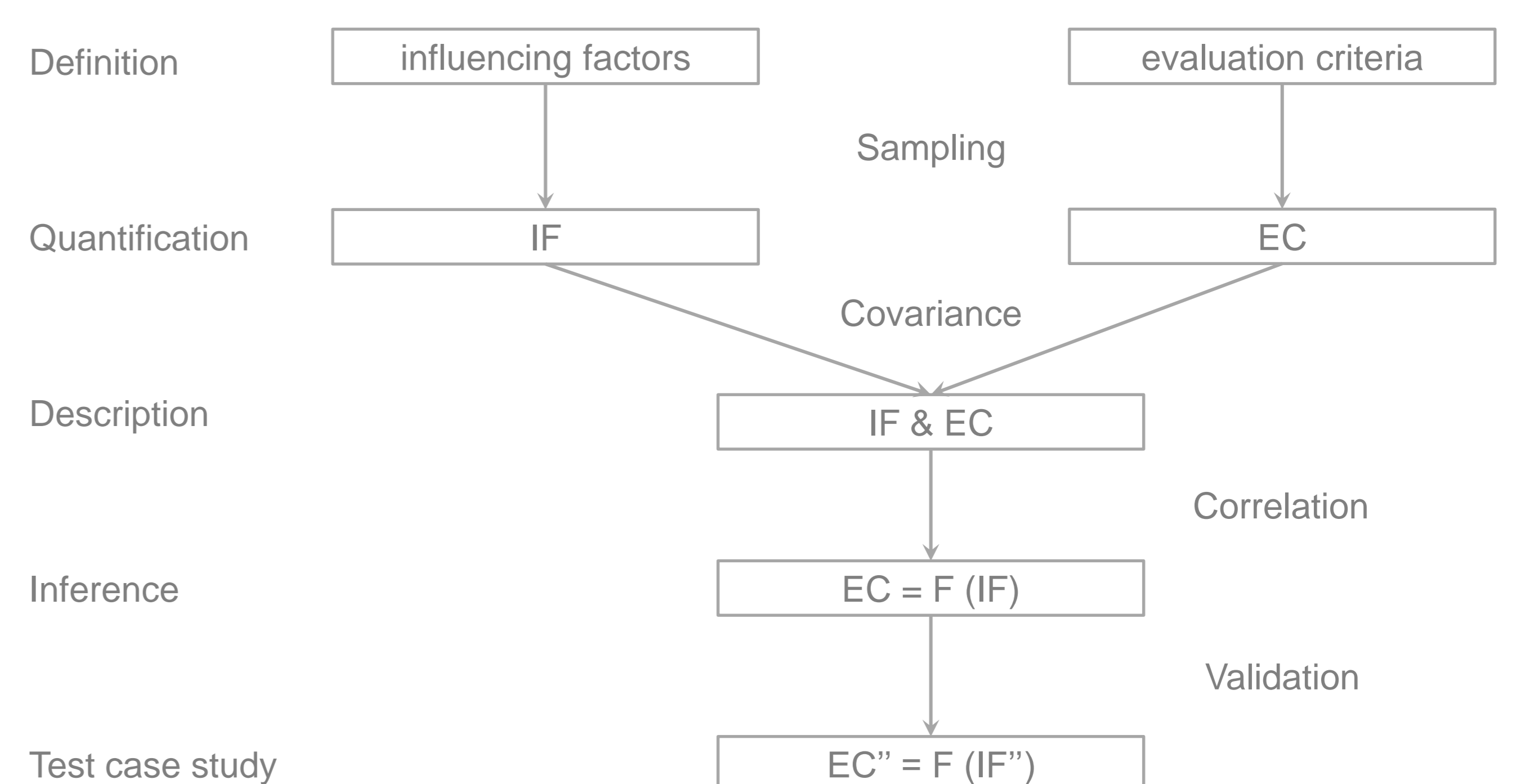
▶ Fig. 4 Renovation permits in Belgium (Statbel, 2017)



▶ Fig. 3 Cooling and Heating degree days (°C) for Belgium (Eurostat, 2017)



▶ Fig. 5 Final energy consumption in households in Belgium (kg of oil equivalent per capita) (Eurostat, 2017)



▶ Fig. 6 Statistical analysis methodology (Ruellan, 2018)

**EXPECTED RESULT : F**

WITH E.C. Evaluation Criterias = F ( I.F. Influencing Factors )

**ORIGINALITY**

- ▶ There is currently no study on the statistical analysis of the results of the actions undertaken in Belgium to increase the renovation rate.
- ▶ It is also important to highlight the side effects of energy efficiency, as these are often the main reasons that lead to the adoption of these measures.

**LIMITATION**

- ▶ Some data are not existing nor available.
- ▶ Evaluation of some EC (comfort) and IF (income, communication, building typologies) => Future studies will make it possible to develop this methodology at the level of Walloon municipalities to integrate technical (through PEB-data) and sociological data.

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