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Sustainable Building Design Strategy From Life Cycle Thinking Perspective
Case Study: a Townhouse in Phnom Penh, Cambodia

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I. INTRODUCTION

The growing building construction in Phnom Penh, the capital city of Cambodia, is lacking attention to sustainability aspects and limited awareness of sustainable buildings topic in the construction sector. Simultaneously, residential building is crucial and most constructed in the city due to the present and future demand of the urban population.

This presented work is a part of the doctoral research project that aims to minimize the carbon and environmental footprint of a townhouse in Phnom Penh, a hot and humid tropical climate. The study uses the application of life cycle assessment (LCA) to the building case study and analyzes proposed strategies.

II. CONTEXT

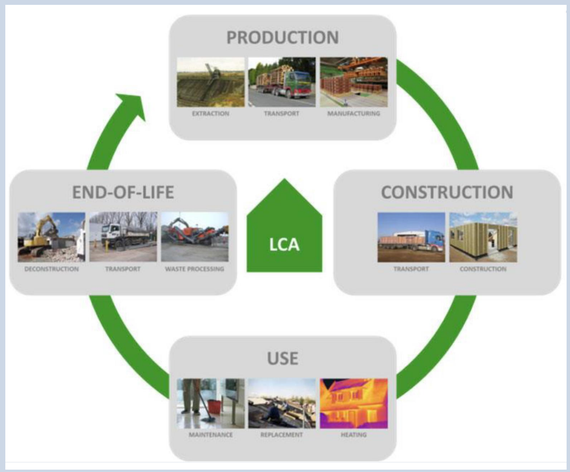

Fig. 1 – Life cycle of buildings

Environmentally, buildings account for 40% of global energy consumption and one-third of greenhouse gas emissions and are also considered a major player in environmental degradation.

Intending to reduce environmental impact, life cycle assessment (LCA) of buildings is one of the innovative methodologies that estimates the carbon footprint and environmental impacts generated by a building throughout its whole life cycle.

III. OBJECTIVES

- Propose guidelines and strategy integrated sustainable building design criteria for residential building (affordable housing) in Cambodia
- Be aware of existing tools, standards, methods, and databases of LCA of buildings and construction products

IV. QUESTIONS OF RESEARCH

1. Which design, strategy, and construction products and technics can be selected as guidelines to be taken into account for reducing the overall environmental impact of the residential buildings, and to be evaluated as green buildings in Phnom Penh?
2. How do available standards, databases, methods, and LCA tools apply to the context of construction in Cambodia?

V. METHODOLOGY

The methodology of this research is developed in six following steps:

1. Analysis of LCA framework and state of art
2. Modeling building components and energy use in SimaPro software using Ecoinvent 3 database
3. Carbon footprint and environmental impact assessment
4. Analyze the result from life cycle impact assessment
5. Interpretation and analyze proposal strategy

VI. PRIMARY RESULTS

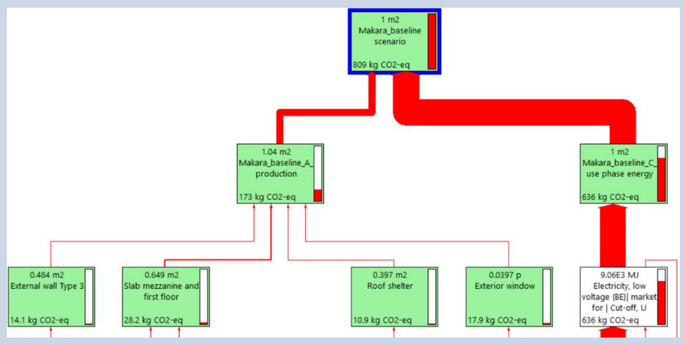

Fig. 2 – Significant influences on carbon footprint, IPCC 2021 GWP100 method

	Baseline		5th Strategy	
Life cycle phases	Carbon footprint [kg CO2 eq/m2]	Environmental footprint [mPt]	Carbon footprint [kg CO2 eq/m2]	Environmental footprint [mPt]
Total	808.93	106.73	494.26	70.66
Production	166.43	34.01	85.89	16.37
Construction	6.66	1.36	3.44	0.65
Use phase energy	635.84	71.37	404.94	53.63

Fig. 4 – Carbon and environmental footprint unit per life cycle phases of baseline and the 5th strategy scenario

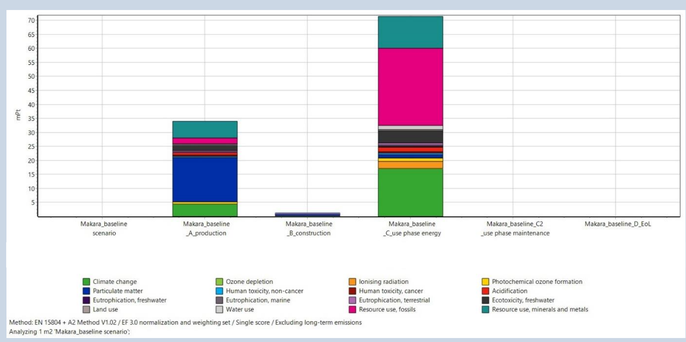

Fig. 3 – Level of single score in impact categories, EN 15804 + A2 method

Fig. 5 – Comparison of environmental impacts of the 5th strategy which combines the 1st, 2nd, 3rd, and 4th strategy

Fig. 6 – Photo and ground floor of the case study

CONCLUSIONS

1. Use phase energy generates the highest carbon and environmental footprint
2. Combined strategy reduces overall impact but increases some specific impact categories
3. The combined strategy reduces about 40% of carbon footprint and 34% environmental footprint