Imperial College London

Time-Cost Analysis for Light Steel Frame Modular Buildings

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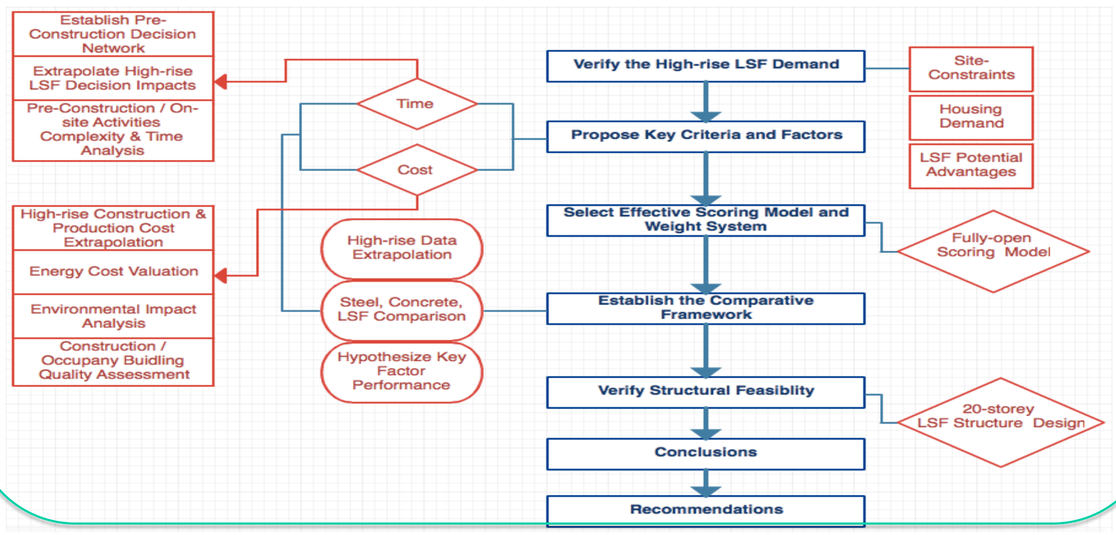
Introduction

The purpose of this research paper is to define an effective comparative framework for high-rise light steel frame modular (LSF), concrete and steel building systems, which includes the search of the importance factor and comparing methodology. This system will be a beneficial tool to all decision makers. Investors and designers, in particular, will be able to identify the building system with the values and impacts that they are searching for in a high-rise project. The focus will be on hypotheses and the extrapolation of high-rise LSF performance from the analyses of low-rise LSF buildings.

Research Methodology and Key Deliverables

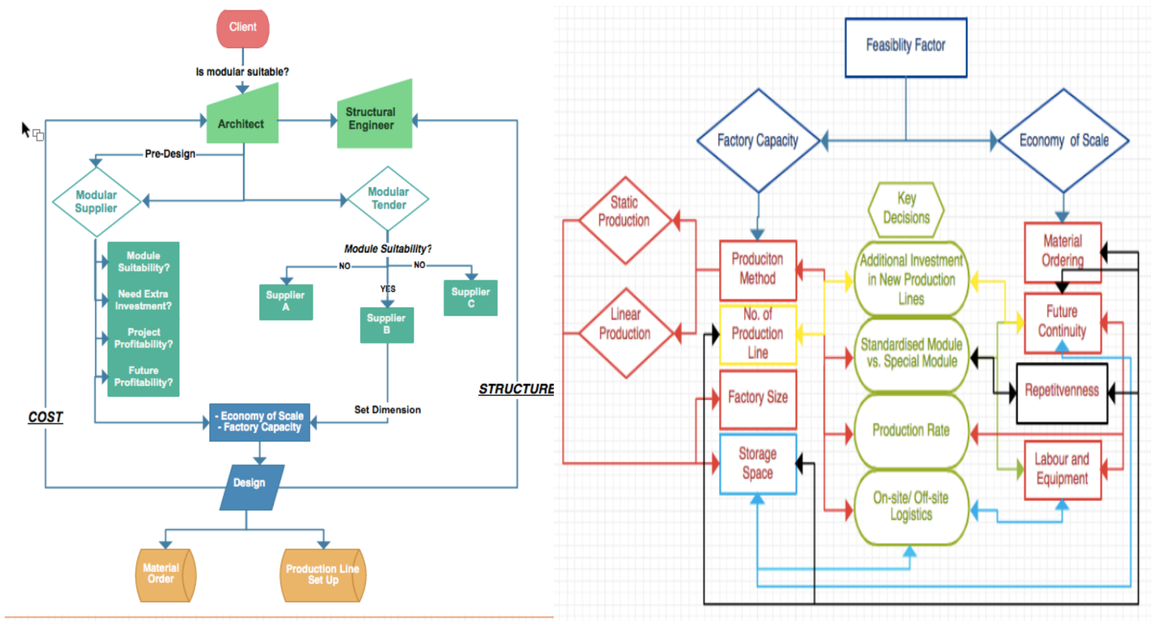


Time Analysis

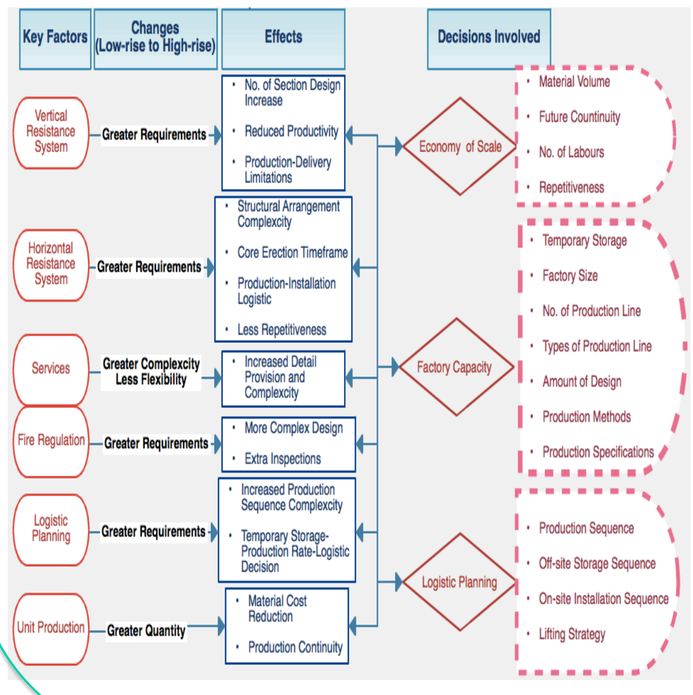
This section focuses on the time value comparison in two stages: Pre-construction and On-site Activities. The research results are shown:

Light Steel Frame Module: Decision Network Structure

Establishing a decision network allows us to identify decision factors to consider for high-rise LSF in the pre-construction stage. The mismatch, unparalleled and scattered information among critical decision makers increases the difficulty in assessing and analysing the preparation process and, therefore, the complexity in the decision network establishment. Below shows the closed-loop decision process and how does key factors influence each other.



Light Steel Frame Module: High-rise Decision Extrapolation



Complexity and risk can be induced from low-rise to high-rise light steel frame modular when considering all listed factors in the Decision Network. Decision and preparation are more time-consuming when accounting for all effects. The pre-construction planning for high-rise light steel frame module is based on an analysis of all the factors discussed above as well as by incorporating opinions from experts in industry.

Acknowledgement

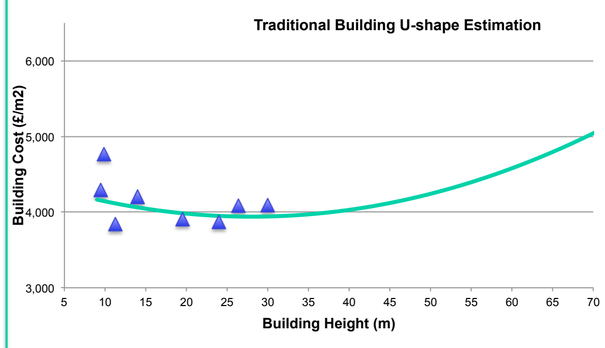
I would like to express my great appreciation to my supervisor Dr. Sunday Popo-Ola, and Ahearn Alison for their valuable and constructive advice throughout this study.

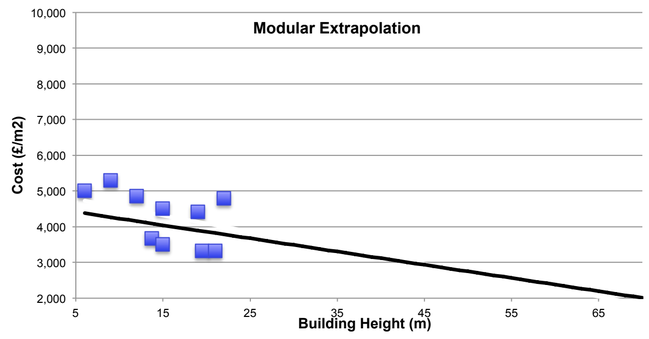
Cost Analysis

This section focuses on the cost value comparison in three key factors: manufacturing & construction, life cycle quality and environmental impact.

High-rise Manufacturing & Construction Cost: U-shape Model

In our cost estimation study, based on the principle of Flanagan and Norman's U-shape model, high-rise light steel frame modular (LSF) building data can be extrapolated from low-rise data, but the cost components categorization for LSF module building needs to be recalibrated by conducting elemental U-shape model analysis. Traditional building is assumed to fit with the U-shape model.





Environmental Impact & Life Cycle Quality Cost Comparison

	Total embodied carbon (tCO_2e/m^2)	GWP factor	Traded-price for carbon (£/tCO_2e)	Emission Value (£/m^2)	% Difference
Module Building	0.38	1	61.79	**23.48**	**48.9%**
Traditional Building	0.75	1	61.69	**46.34**	

	Total embodied energy (kWh/m^2)	GWP factor	Marginal emission factor ($kgCO_2e$/kWh)	Traded-price for carbon (£/tCO_2e)	Emission Value (£/m^2)	% Difference
Module Building	1361	1	0.341	61.79	**28,676**	**51%**
Traditional Building	2778	1	0.341	61.79	**58,533**	

This section assesses the cost value of the environmental impact. The cost value comparison of greenhouse gas (GHG) emission and energy used for both LSF and traditional building systems is based on the guidance provided by HM Treasury Green Book on Appraisal and Evaluation (2014), but modification is done to fit for our comparison.

Final Result: The Scoring Comparison

Final scores and weighting are given to each performance indicators after estimation, analysis and comparison. The breakdown and summarised scores are shown below: