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Investigating Building Construction Process and Developing a Performance Index

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Abstract

A typical building construction process runs through three main consecutive phases: design, construction and operation. Currently, architects and engineers both engage in the creation of environmental designs that adequately reflect high performance through sustainability and energy efficiency in new buildings. Occupants of buildings have also recently demonstrated a dramatic increase in awareness regarding building operation, energy usage, and indoor air quality. The process of building construction is chronologically located between both the design and the operation phases. However, this phase has not yet been addressed in either understanding contractor behavior or developing innovative sustainable techniques. These two vital aspects have the potential to levy a dramatic impact on enhancing building performance and operational costs.

Repeatedly causing apprehension to the construction industry is a question that posits, "Why is there a gap/delta/inconsistency between the designed EUI, Energy Use Intensity, and the operational EUI"? Building occupants shall not be the only party that bears blame for the delta in energy. It is true, nonetheless, that occupants are part of the reason, but the contractor – as well as the entire construction phase - also remain prime suspects worth investigating. In the present time, research is predominantly focused on occupants (post-occupancy) and designers to educate and control the gap between designed and operational EUI. This research has succeeded in the identification of the construction phase, in conjunction with contractor behaviour, as another main factor for initiating this energy gap. Therefore, not only is the coupling of sustainable strategies to the construction drivers crucial to attaining a sustainable project, but also it is integral to analyzing contractor behavior within each of the construction phases that play a vital role in successfully serving sustainability. Various techniques and approaches will assist contractors in amending their method statements to ensure a sustainable project.

This research correlates an existing project to the two proposed sustainable concepts: 1) Identify cost-saving strategies that may have been implemented or avoided during the construction process, and 2) Evaluate the impacts of implementing these strategies on overall performance. The adopted contexts are to partially foster sustainable architecture concepts to the Contractor

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process, and then proceed to analyze its cost implication on overall project performance. Results of the validation of this approach verify that when contractors embrace a sustainable construction process the overall project will yield various financial savings. A mixed-use project was utilized to validate these concepts, which indicated three outcomes: firstly, a 25% decrease in manpower for tiling while maintaining the same productivity, thus reflecting a saving of $3,500; next, increasing the productivity of concrete activity, which would shorten the duration of the construction by 45 days and reflect a saving of $1.5 million, and last of all, reducing the overhead costs of labor camps by efficiently orienting temporary shelters, which reveals a reduction in cooling and heating that returned a saving of approximately $10,000. This research develops a comprehensive evidence-based study that addresses the above-mentioned gap in the construction phase, which targets to yield a multi-dimensional tool that will allow: 1) integrating critical thinking and decision-making approaches regarding contractor behavior, and 2) adopting innovative sustainable construction methods that reflect reduction in operating costs.

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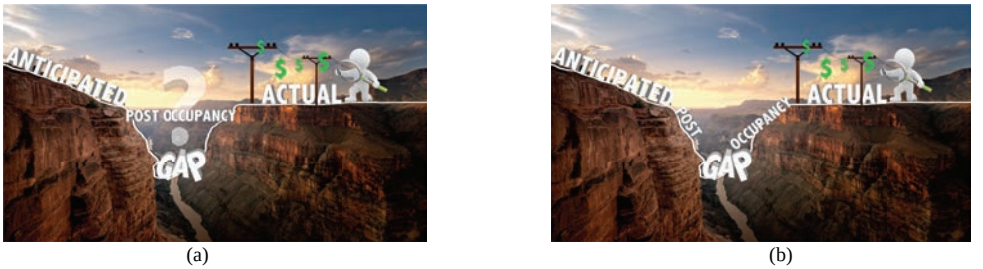
Keywords: Sustainable Construction Process; Embracing Sustainable Architectural theories into Construction process; Innovative Construction Approaches; Contractor Behavior; Performance Based Approach; Energy Gap

1. Introduction and Impact of the Problem:

Fluid design, energy-efficient, eco-friendly, naturally lit and ventilated; these are some of the sustainable terminologies we often hear concerning buildings, and they are all very valid concerns. Nevertheless, did you know that the Building Industry consumes nearly half of all energy produced in the United States? In addition, buildings are liable for over 35% of total energy use, as well as being accountable for more than 70% of electricity consumption [1]? The statistics are simply staggering. It is also important to point out that the building industry is regarded as the largest emitter of greenhouse gases on the planet, the greatest contributor to CO_2 emissions and waste outputs [2].

However, research will draw attention to another critical aspect of the building process. There is very little awareness about the complex intricacies that factor into the various phases of the construction process. In fact, the building industry is regarded as the infrastructure on which the economy is built. This fact is very unfortunate for us who work within the field of construction, as a blind eye is often given to the criticality of the construction's impact on the entire process, despite construction representing the main component of the economy. In the United States, more than 7.5 million jobs are sustained within the construction sector alone, proving just how vital this lifeline is to our economy [3]. This research sheds light on the construction process from a sustainable perspective, hence embracing sustainable approaches within the construction industry.

Energy performance ambitions established during the design phase must be carried through all three phases for energy performance outcomes to be achieved. Currently, many architects and engineers provide enhanced evidence-based designs that reflect improved energy efficiency. On the other hand, tenants have demonstrated a dramatic increase in awareness concerning building operation and energy usage. The process of building construction is chronologically located between both the design and the operational phases; however, a lack to understanding of contractor behavior, in addition to the extent of sustainable practices used on-site and how these aspects are subject to affecting a building's energy performance, may be creating a barrier to achieving targeted energy performance outcomes.



(a) (b)

Fig. 1. (a) Claiming that post-occupancy is the only founder of the energy gap between the anticipated and actual design; and (b) the research's perception of the post-occupancy not being the only factor creating the energy gap between anticipated and actual design.