Cost Effectiveness of Implementing External Facades System.

Abstract

Façade is a major building component with the potential for enhancing sustainable construction through effective preservation of energy and economic contributions by using green materials, labour, and plant. Therefore, it can be an important contributor towards sustainable development goal. In recent times, many innovative building facades are evolving, with the aim of ameliorating the challenges relating to environmental and energy factors. Building facades are capable of behavioural changes in real-time such as change of indoor and outdoor factors in response to any environmental situations thereby improving efficient use of energy. Although the need for building façade is increasing, the success of these innovative building façades will depend on balancing technical specification and application of innovative/green materials with cost benefit realised on a long term. However, there is lack of detailed information of the initial cost impact during the design stage, necessary for evaluating their cost savings or any inherent economic benefit to support informed decision.

To address this, this research aims to evaluate the cost impact of using building facades in building projects in terms of its sustainable benefit, relative to the economic challenges and benefits to the built environment. A secondary research approach using existing cost information/data substantiated with explorative view from professionals working with facade systems is adopted. The research reveals the significance of considering cost benefits using life cycle cost rather than the initial cost to support informed decision-making on the use of building facades as a means of enabling a sustainable built environment.

Key Word: Mega Building, Facades, Cost-benefit, Life Cycle Cost, Sustainability

1. Introduction

Building facade is an important part of any mega building, capable of reducing energy demand and environmental impact by designing facades to react to any externality factors through the various seasons of the year (Mazzucchelli et al. 2018). Building facades can be designed to withstand any changes in environmental conditions with the primary aim of improving building performance (Loonen et al. 2015). Also, to provide the necessary flexibility in achieving nearly zero energy buildings or interactive energy efficient level for any mega building. The building facade helps to maintain both external (weather) and internal environmental effects created by human factor whist such facades must be structurally sound, aesthetically pleasing, and enhance vision with satisfactory energy performance (Chew et al. 2004; Ihara et al. 2015). According to Eleanor et al. (2002), some of these facades are not meeting their functional requirement and cost benefit based on their life cycle analysis. There are records indicating that their initial cost is not beneficial on the long run due to their performance (Underwood and Alshawi 1999). Consequently, this creates a challenge for clients in making decision on appropriate facades for their project due to the significant operational and maintenance costs. Hence, client decision must be based holistically on a long-time performance consideration not solely on initial cost (Bourker and Davies 1997).

It has been reported in past studies that the cost of repair and maintenance for building facades will increase where there is known planned maintenance in place, the cost increase will depend on the material composition and different maintenance policies that can be implemented during the building's life cycle (Flores-Colen and de Brito 2010). If this is not addressed with the way mega buildings are springing up around the world, the cost of repair and maintenance might end up overtaking the construction cost (Chew et al. 2004) which is not desirable. The cost of maintaining building facades increases in proportion to their functional performance due to difference in regional humidity and temperature (Chew et al. 2004), and quality of design and installation (Al-Hammad et al. 1997; Gibb 1997). Some of the defect experienced in building facades are because of poor workmanship, inadequate or lack of planned maintenance resulting in additional cost (Ong 1997; Shohet et al. 2002). Minimizing the cause of defect is important in controlling operational cost whist maintaining utmost performance of the building facades (Ledbetter and Keiller 2001; Mayer and Brewer 2001). This emphasises the need for clients' awareness of cost effect and economic benefits of building facades in reducing cost of energy whilst contributing to carbon reduction. Therefore, this study will investigate the cost impact of building facades to support decision making on the use of facades for sustainable building goal.

2. Literature Review

2.1 Challenges of Mega Building Facades

The building facade is described by Kaluarachchi et al, (2005) as a barrier between inside and outside of a building that prevent hostile environment and can also be describe as a building skin or envelope that helps to control the impact of environmental factors. While building façade refer to external appearance of a building, building cladding is the external protective layer of the building. Both terms referred to the external part of building structure. Apart from the functional requirement expected from facades such as being glare free and able to reduce noise pollution (Kaluarachchi et al, 2005), the sustainability level with cost impact also needs to be analysed to enable clients make an appropriate decision. One of the most challenging issue is that most facades are highly glazed which has been encouraged for over 20 or 30 years running due to their energy efficient and sustainable feature, but this falls short in terms of being cost effective (Selkowitz 2001)

A lot of innovative process has emerged into the design of building facades process which require great approach to decide if a particular design is viable (Eleanor et al. 2002). Hence the need for integrated approach between all the stakeholder to decide the most cost effective, high performance, functional, comfortable, energy efficient and aesthetic or inspirational facades. Occasionally building facades has been seen as integrated systems due to some suggestions by Eisenberg et al. (2002) which include: lack of understanding of its functional requirement in building, procurement constraints, conflict of interests, ineffective communication, and collaboration among stakeholders. Also, various stakeholders are involved in the making decision including the client, architect, facades specialist, Mechanical and Electrical (M&E) Engineer, fire engineer, structural engineer, construction manager, lighting engineer, value engineer and quantity surveyor. The decisions of these various stakeholders are sometimes conflicting resulting in additional cost which will lead to value engineering being perform at the early stages of the project (Eisenberg et al. 2002).

The main challenges observed with facades are around technicality and constructability where new technology is employed for installation or during integration into the building (Commonwealth of Massachusetts. 2001). When planning Mega building facades, life cycle cost (LCC) must be considered together with the initial cost of the building facades (Eisenberg et al. 2002) to enable the clients make more informed decision by not only considering the initial cost of the façade. Specific performance of mega building facades needs to be taken into consideration, in term of its energy efficient, comfortability, acoustic property, environmental control and greener factor, lower operating and running cost if planned, designed, analysed, installed, operated, and integrated properly (Selkowitz 2001).

It is a challenge when matching building end users with building purpose during post construction (Eleanor et al. 2002). This may result in clients or ends users discontent because of predetermine design requirement which determine the usability requirement or building purpose leading to underutilisation of the building. This make building façade complex with their functionality relied on proper usage and operation, planned maintenance and technical know-how hence the facility or building manager and end users need to be provided with the operational document and learn how the façade work and interact with the building function (Commonwealth of Massachusetts 2001). Care must be taken for optimum performance of the facades that the components are easily procurable during maintenance, the facility or building manager must be able to measure and monitor the system performance by comparison with original performance goals through monitoring the equipment and technician involved. Otherwise, the facades performance will be under-utilised with more maintenance cost.

2.2 Cost Consideration in Building Facades

Generally, facades are formed in different shape and style due to technology and material innovation, and improvement in technical and production competencies (Saeedi 2017). Building facades has evolved over the years and continuously shifting away from the use of traditional form of concrete to other innovative material such as: wood, aluminium, ceramics and concrete fibre for prestige and aesthetics purpose (Lesniak and Gorka 2020). Getting the choice of facades right comes with deciding on the right quality, cost of materials and time schedule (Lesniak and Gorka 2019). Estimating the initial cost of facades at design stage can prove challenging due to the limited information available at the early stage. Hence, professionalism comes into play by taking into consideration all design information from conceptual stage and making adequate allowances where necessary to reflect the project location and onsite assembly including any indirect cost (Lesniak et al. 2019). Many of the influencing factors for cost of façade include cost of works, risks, safety, and energy intake. Lesniak and Gorka (2020) in their recent study has grouped those factors into five categories (i) type of materials, (ii) characteristics of facility, (iii) contractual condition, (iv) level of aesthetics and (v) macroeconomic factors.

Building facades help to reduced energy consumption, lower initial cost, improved user's satisfaction, increase intensity of buildings and performance (Kaluarachchi et al. 2005), improved acoustic property and promote green infrastructure (Arup 2018). It can provide advanced systems of reaction and high levels of control apart from heat and light control (Pacheco-Torgal et al. 2013; Pacheco-Torgal and Labrincha 2013). It is very important that clients get value for their money and their project attains the proposed project value (Arup 2016). Hence, the significant of measuring the economic

benefit when making technical decision on facades by providing quantitative evidence rather than the simplistic method of qualifying their benefit. This could in turn make cost analysis on facades simpler for stakeholder when deciding to invest in sustainable development in aid of UN Sustainable development goal. The benefit to the users must be prioritise when specifying facades for any building by encouraging the clients to quantifying the benefit before making decision (Clements-Croome 2018).

In terms of cost, building facades represent about 15 – 40% of total building cost (Hall 2002) and studies have reported the cost of maintenance to be in the range of 5 – 10 times the initial cost (Kaluarachchi et al. 2005). Innovative facades help reduce energy usage whist improving comfortability without incurring any extra costs, with quality designed to help reduce energy costs by 30% (Kragh 2001). According to the UK professional standard used for early stage estimation (RICS 2012), the estimation of building facades can be measured during the conceptual design stage by quantifying the area using the conceptual design to measure the perimeter of the building and multiplying this by the floor to floor height. Another method is using the ratio of materials to measure the cost of facades where no drawing is available. This means using the ratios of exterior wall to the building gross floor area (wall/floor area ratio). This information is derived from previous benchmark and similar project, the higher the ratio, the less efficient the building design, most of this fall between 0.35 (more efficient) to 0.60 (less efficient), which helps to identify any cost saving potential or issues while changes can be made early on the project to avoid cost changes (Meese 2018).

Other factors that can affect the cost of building facades includes material selections, material quantities/ratios and the unit price of material. Some of these will depend on the client/architect preferences, project type, location, availability of products, labour, adjacent building facades, building regulation/codes, ballistic requirement, building shape, building access, fire resistant requirement, wind/hurricane load, sustainability requirement, and quantity of work and provision of rooftop screen walls (Flores-Colen and de Brito 2010; Meese 2018). The initial unit cost of a building façade is estimated from historical data with allowance provided for special risk factors to benchmark against similar project within the locality (Meese 2018). The decision making process must be transparent with all parties given the same information concurrently to reach their decision. Advancement in technology has helped in overcoming the difficulties in decision making process, such innovative technology can help make such decision in term of performance and its impact (Eleanor et al. 2002).

3. Methodology

The approach adopted in this research study involves the use of secondary data from existing research studies comprising of a qualitative exploratory review by professionals and experts who are experienced in working with building facades either through their consulting or contracting roles. The explorative view of the participating professionals was based on the following premise: Cost impact and performance to invigorate the dialogue. Table 1 presents some background information of the professionals.

Table 1: Background information of participating professionals

Participant	Architect	Quantity Surveyor	Façade Specialist	Construction Manager
Experience (Years)	20	25	23	18
Past Project (£)	15m	22m	7m	30m

4. Findings and Discussion

4.1 Cost Data Result

Building facades are relatively expensive due to being priced as a composite item featuring all the component which are normally described with an omnibus description in the contract document, it is a specialist work which is subcontracted out and pricing are normally carried out by the subcontractor's estimator with the contractor adding its percentage profit and overhead. The cost of facades differs and increases within different quarters of the years, depending on the quality of material or specification used including aesthetic and functionality requirement, where there is additional feature provided like blinding, this does not include cost of maintenance.

Facades are expensive to installed and time consuming, sometime attract an additional installation cost which can be in the region of 20 – 300% (Arons, 2000) with some hidden cost which are not disclosed by the clients. Offsite assembly facades are less costly compared to onsite assembly facades.

4.2 Results from Professional/Expert review of façade cost.

Participating reviewers were asked to identify factors that determine client's consideration for building façade based on cost impact and performance, majority of the participant agreed that enhancing the performance requirement of the building is very important to the clients hence, they concluded that energy efficient and sustainable requirement top their list, which was follow by the quality of end users' services. Aesthetic was some worth considered important but not as critical as, innovative installation which was not seen as important but a desirable consideration. Eleanor et al (2002) concur, stating that the performance and not style should be considered when making such critical decision. The Architect concluded by saying that, their design speaks volume of their work, they are usually wanted to produce an aesthetic design with quality specification in support of their design, they all agreed that sustainability, environment, quality is among other factors been consider for using building façade.

The participating reviewers were to discuss information they will required to make decision on the use of building façade, within their deliberation the most prominent information is through architect design information followed by similar project and others which include – family advice, website with cost as the least requirement from the participants whist the quantity surveyor concluded by saying that such analysis should be based on performance enhancer, anything that will augment the actualisation of project objective and improve the building performance rather than

external influence or architect advice who are known to favour aesthetic in their design decision, should be the deciding factor. When further question was asked concerning their opinion on cost effect on the use of façade, most of the participant agreed that the initial cost is a barrier because the clients do not want to go over their arranged cash flow while public organisation will be conscious of budgetary allocation and speculative developer would want to maximum profit on their investment (Eisenberg et al. 2002). The quantity surveyor commented on this saying that whatever might be the initial cost, it should not be the determinant since façade is known for its energy efficient, carbon reduction and environmental performance, this will offset some of the maintenance and operation cost which is the reasons that is making facades very expensive (Eleanor et al. 2002). It was generally agreed that before any decision is made based on cost, it should be considered completely with the initial cost by measuring the cost benefit analyses which can be compared with the project performance.

Reviewer	**Architect**	**Quantity Surveyor**	**Façade Specialist/Engineer**	**Construction Manager**
Key Summation	Many of us in this business want our work to standout in term of aesthetic and the need for compliance with sustainable goals not necessarily concern about cost. Our design is our selling point, we often get inspired or innovative with our design sometime we consider design consideration between 1 and 2% rather than full cost consideration.	It is an inappropriate things to consider only the initial cost over the LCC in making decision about the facades to use, it is possible to have facades that cost cheaply initially but high maintenance and running cost. It is our role to educate the client during cost consideration of their project.	There are some point in using the initial cost over the LCC when deciding type of facades, like the nature of design or cost limit, the design can affect the type of façade to use or where there is no room for additional cost especially speculative developer who want to deliver their project with minimal cost is different from government where polities play major roles over other things including cost for example the millennium dome where fulfilling the millennium objectives is important over the cost of replacing/maintaining the facades used for the project.	Installation of proposed façade system is an issue we do consider. The façade material may not fit in every situation or location, making it difficult to install or construct especially if new innovation is introduced, we do not necessarily look at any cost either early stage cost or users cost but how to manage the installation at a profitable way.

Key word from Reviewers Contribution.

This is essential in making an informed decision on cost implication of building facades. It is insightful to see the effect this will have if such decision is based on aesthetic, structural component, or buildability, it should encompass everything that will enhance its value (function, social, economic, and environmental value) with the cost component before a decision is made either on its usability or the need of implementing it in building. It is essential for the design team to not only focus on the

delivery of the project, the cost effectiveness of the materials specified should also be considered. Also, it is important to consider the relationship between the function of each element like façade with cost and value when estimating the project cost especially at the technical design stage.

5.0 Conclusion

Considering the benefit associated with the use of facades in mega building, it is difficult to neglect this despite the high cost of installation and other sundry expenses, a holistic cost approach must be developed to help the stakeholder make an appropriate decision of building facades. The initial cost might be low with the addition of running and maintenance cost this will be unbearable for the clients when making decision but effect must be made to carry out the cost benefit analysis and involve the quantity surveyor at the initial stage to advice on any alternative without jeopardising the quality whist the clients should be updated on the cost implication at every stage of the project in order to budget for any contingencies in other to achieved maximum benefit for its used.

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