

Construction Claims: Impact of Defective Construction on Long Term Facility Maintenance Costs

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Abstract

The industry is becoming one of the leaders in producing and implementing sustainable building metrics by promoting the use of renewables, Green Building, Lean Building and LEED Construction. The newly introduced changes present challenges to sustainable construction and has led to more companies and stakeholders promoting integration of all construction phases. This study was conducted to quantify the impact on defective construction procedures and methods on sustainable construction projects' recurring facility maintenance costs. The research data was collected from public school facilities constructed under a sustainable construction program. These projects have been completed in the past 10 years and with occurrences of construction defect claims. The results of this study will be in the interest in project owners and stakeholders with a focus on lowering facilities maintenance costs on sustainable facilities.

Keywords: Defective construction, Facility Maintenance, LEED, Maintenance Costs Sustainable construction.

Introduction

The objective of this study was to identify the cost implication that defective construction have on long term facility maintenance cost for projects that were constructed under a sustainable construction program or guidelines. Often, such projects involve new technologies, innovative material and construction procedures that can be implemented incorrectly, having a subsequent effect on the facility maintenance cost. Sustainable construction projects that have construction defect claims have associated facility maintenance costs from unplanned maintenance. This study is intended for construction project owners and stakeholders to show relevance of cost over runs in facility maintenance costs that are a direct result of defective construction. Sustainable construction methods have been introduced to enhance sustainability but experience has shown that there are current studies that report increases in planned and unplanned facility maintenance. This study will highlight the conditions and trades that have a higher risk of related budget overruns. New products and technologies are being introduced to the construction industry to promote sustainability of new construction projects but at what cost to the owners.

Background

Concept evaluation

Sustainable construction covers many aspects of the methods and practices involved in the construction process and providing the proper training for the trades and the efforts to achieve the desired results can be a challenge. Sustainable construction practices without proper workforce

training have the potential for defective workmanship. Defective construction work by trades can lead to costly construction, costly mitigation and long term cost impacts on scheduled and reoccurring facility maintenance. Defective construction claims to / on this study are a result of alleged damage to a built structure by the contractor who is the general liability policy holder (Bell, D, 2006). Parties involved in a defective construction dispute are aware that the liability of defective construction is purely contractual and the insured party may be more concerned with the customer relations and business reputation that will be affected by the defect allegation (Bell, D, 2006). This study does not look at how frequent sustainable construction projects are subjected to occurrences of defective construction, but instead it investigates what rate sustainable construction defects effect the whole life cycle cost just on facility maintenance.

This study is a continuation of previous studies conducted to research how large investments of / in capital project deemed green building or LEED construction have fared for return on investment. Other studies have focused on the overall value of money (VfM) invested in major capital projects. VfM entails developing cost effective solutions that ensure optimal performance and takes into account long term operation, maintenance, and rehabilitation costs of buildings over their entire life span (Issa, M. H Et al, 2013). VfM in a sustainable construction projects / projected leads to "Spending more for less" where high designs / designed specifications increases the capital cost (Wang, N, 2013). In order to achieve this goal the increased capital cost has to be compensated by a reduced whole life cycle cost (Wang, N, 2013). Defective construction on a capital project disturbs the continuity of this principle, changing the proposed overall VfM outcome of maintenance costs.

Where other studies focused on the project total capital and total life cycle cost, this study was focused solely on cost implication in facility maintenance and what effects construction defects had on their budgets. In achieving sustainability, maintenance of buildings and its facilities become an important criterion and is vital in ensuring the buildings sustainability (Au-Yong, C. et al, 2014). Like the larger studies on sustainability in construction, the amount of available empirical data is still lacking and very little work has been conducted in the assessment of this topic (Issa, M. H et al, 2013). How a green firm performs remains unknown, and this knowledge gap pose a major challenge (Lu, Y. et al, 2013).

The school facilities in this study were all built after a 2005 ordinance was issued from / with the Miami-Dade public school district to construct, rehabilitate and maintain all public facilities as sustainable developed buildings. This ordinance was issued after a slew of issues hit the school district hard with rising and out of control maintenance costs on existing facilities cost . This lead to over budgeted long term maintenance costs on conventional constructed facilities. In October of 2005, the Miami-Dade Board of County Commissioners approved Resolution R1200-05 establishing the incorporation of sustainable development building. This was a measure to be incorporated into the design, construction, renovation and maintenance of County-owned, County-financed and County-operated buildings. Then in 2007, the Miami-Dade Board of County Commissioners further approved Ordinance 07-65 and order IO 8-8 establishing the sustainable building program for the operation of all county facilities. The conditions of the debilitating school facilities county wide forced the school board to take action to restructure the conventional methods of construction.

Planned and unplanned facility maintenance

Sustainable facility maintenance has three objectives; minimize life cycles cost, minimize life cycle carbon emission and target the right level of life cycle employment opportunity (Chiang Y. et al, 2014). Building maintenance is vital to ensure the buildings sustainability (Au-Yong, C. et al, 2014). Maintenance is defined as a combination of actions carried out to retain an item in, or restore it to an acceptable condition (Lee and Wordsworth, 2001). Preventive maintenance and corrective maintenance are two forms of sustainable facility maintenance used in this study to account maintenance cost resulting from defective construction. This study looked at the practices of preventive maintenance by in the Miami-Dade schools to determine what level of activity was planned and which activities were not.

Sustainable facility maintenance is based heavily on planned preventive maintenance. Preventive maintenance is an effective approach to enhance the reliability and quality of a system and its components (Au-Yong, C. et al, 2014). Preventive maintenance is planned maintenance that involves keeping skilled labor on staff full time, having quality replacement parts available as needed and having an adequate budget in place to perform routine maintenance. Planned maintenance is vital to prevent system failures and to avoid unnecessary and costly downtime. Planned maintenance should be the majority of the maintenance activity which keeps the costs down while unplanned maintenance should be minimized to achieve optimal maintenance expenditure (Au-Yong, C. et al 2014). This study looked at what maintenance tasks were planned and budgeted for and what unplanned maintenance tasks were performed in response to failure or damage.

Unplanned maintenance reduces sustainable facility maintenance by increasing overall maintenance cost. Unplanned maintenance is considered corrective maintenance because it takes place after a system has failed and repairs have to be done to correct damages. To minimize maintenance cost unplanned maintenance had to be minimized. Unplanned maintenance was the source of tracing costs attributed to defective construction in this study for data collecting purposes.

Methodology

The information collected and generated for this study will be pulled from 31 public school projects in the Miami-Dade County Public School District that were constructed after 2005. As mentioned in figure 1, the breakdown was for 9 elementary schools, 9 K-8 schools, 7 middle schools and 6 high schools. Miami-Dade has over 415 schools in operation and has constructed over 40 schools since the implementation of ordinance Resolution R1200-05.

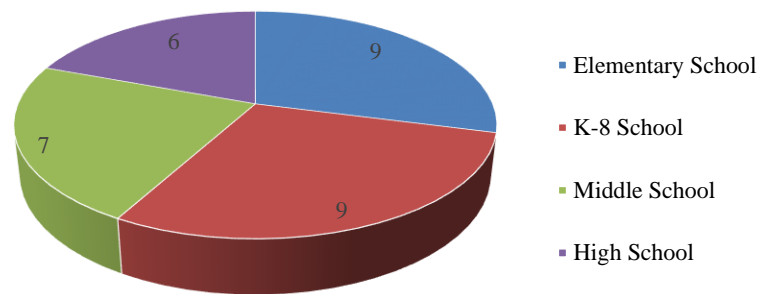


Figure 1: Breakdown of school types constructed in the Miami-Dade County after 2005

That ordinance required sustainable construction and maintenance for all public facilities. The Miami-Dade school district was selected for this study for its sufficient volume of newly constructed facilities after the year of 2005 and the policy of / on sustainable construction. The criteria guidelines established on the projects in this study looked for resulting construction claims that were filed for defective workmanship or defective construction, the projects' constructed must have been completed within the past 10 years under the sustainable construction ordinance and must be in the Miami-Dade County School District.

Public records will be pulled on all facilities that meet the stated criteria to evaluate the financials records that are available on the facility management budgets. The cost that will be used in the data analysis will be the overall facilities cost of 2007/2008 school term of / with 2011/2012 school term. The data analyzed will be the 5 year planned proposed budget vs. the actual budgets. This study focused on the variances between / in the maintenance costs of planned and unplanned maintenance performed over a 5 year planned term. The higher variance costs were traced back to any defective construction accounts on each project. The data collected was profiled and the resulting figures were evaluated to establish a notable pattern that supports the proposed objective. Sustainable construction projects with construction defects claims have higher facility maintenance costs.

Data Analysis

All these projects were constructed during 2005-07 and facility management cost were collected during the period of 2007-12 from the school maintenance record per trade. The data range was collected from maintenance budgets posted from the complete project priority lists of the Miami Dade school districts "Tentative Facilities Work Program". This documents / documented reports all facility projects in the school district on a 5 year work plans. It gives the current years actual facility maintenance cost along with a 5 years projected cost. R1200-5 went into effect of / on 2005 and Ordinance 07-65 IO 8 went into effect in 2007, so data collection in this study started for year 2007. The data was analyzed for maintenance costs of in mechanical, electrical, plumbing, building systems and carpentry. These areas were prime areas for planned and unplanned maintenance with higher reported accounts. HVAC was the primary focus on the highest percentage of activity on the maintenance reports. This study did not include maintenance performed by outside vendors. Based on internal audits performed on new construction from 2005 to 2008 and a maintenance audit performed from 2007 to 2011, the data received on construction defect change orders and verifiable maintenance was limited and not accurate. The contributing reasons noted on the audit

reports on sub-standard activity were due to a period of rapid student body growth of the district, a steady increase in cost of the construction industry for labor and material, the Miami-Dade area being badly damaged by 3 hurricanes and exclusive CM at risk "fast tracking" contracts for accelerated construction schedules (Fernandes, V. et al, 2009). These resulted in a severe lack of tracking and accountability for invoicing.

In 2006 the preventive maintenance tasks were budgeted to increase from / to the planned five year period based on tentative facilities work program documented issued by M-DCPS district, but the actual costs of the selected schools targeted in this study decreased. This study did not discover the attributing causes for the maintenance cost increasing or decreasing over the planned five years. Out of the 31 school projects in this study, 11 facilities have reported change orders linked to defective construction as a result of errors, omissions and scope changes. The change orders and court settlements total \$7.3 million for this study. The trades affected by the change orders and claims ranged from electrical, mechanical, site work, plumbing and building systems.

Results

The results from the study revealed patterns show the relating patterns of increased cost on constructive projects with defective construction claims and those without. Figure 2 shows the cost comparison of school maintenance cost versus defective construction & errors Cost per trade. It was observed that in a building system, small defect is more than likely to enhance the maintenance cost during the operational life of the building. In electrical areas, if the defect is corrected then recurring maintenance cost impact is lowest as compared to all other trades measured in the survey. Recurring maintenance cost is the highest for construction defects in the Building Systems and lowest for the Electrical works. Construction defects in the HVAC Systems had the second highest impact on the recurring maintenance costs. Recurring costs arising from construction defects in roofing were found to be higher than Plumbing/Sewer or Carpentry/Structural trades. The recurring cost projections are for the projects with construction claims or defects that lead to an increase and cost over runs for facility management costs. Life cycle costs for facility management are developed during the design phase when the construction professionals are developing the project performance concept. The life cycles / cycled expectancy and performance is used to develop a correlating plan and cost model for the life cycle maintenance costs. When there are construction defects in projects that increase the capital cost, there should also be an expectation that there is going to be cost increase in facility management cost during the life cycle of the facility. The conclusion of the study would empower the owners to better predict likely maintenance costs in different trades.

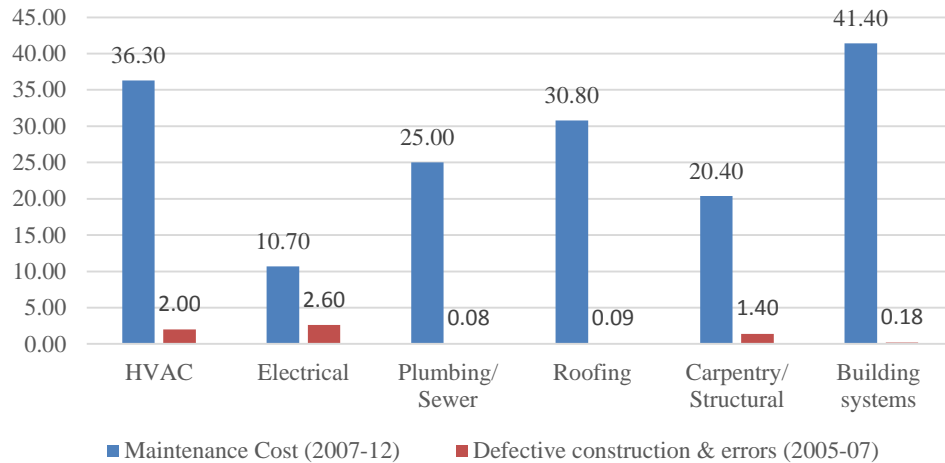


Figure 2: School Maintenance Cost versus Defective Construction & Errors Cost per trade (In millions)

Future Research

The results of this study show a need for further studying the impacts construction defects on higher facility maintenance costs that contributes to the overall long term maintenance budget. Defective construction is one contributing factor of high frequency and costs towards facility maintenance costs. The six trades, used in this study, are the prime areas where facility maintenance costs escalate. In addition we will also need to establish facility management cost increase for green building with construction defects in future studies. Establishing metrics that can assist in controlling the defects during construction is crucial towards lower long-term facility maintenance costs.

Conclusion

The results of this study showed the impacts of defects in construction trades towards higher facility maintenance cost in the respective trades. The public school projects assayed in this study clearly demonstrated construction defects lead to higher maintenance cost in the respective trade or enlarged the scope for maintenance costs, whether planned and unanticipated. Poor workmanship or planning and in particular green construction projects are more likely to have increased maintenance costs, since green construction projects cost more to construct. Variables on cost of construction can be tied to the cost variances in life cycle costs of facility management. In future studies, an effort could be made to identify a mathematical relationship between maintenance cost and defective construction in different trades for other categories of buildings.

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