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Maintenance Architectural Building Evaluation Process: Higher Education Existing Buildings

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Abstract *— Facilities are a major part of college and universities. They play a role of great magnitude in sustaining the quality of life for students, faculty, and staff. Every building aspect supports the lecture halls, dormitories, research facilities and work areas. Higher education existing buildings require a capital throughout its life cycle process to be able to provide with a good quality building or facility to the users. Higher education existing buildings are increasingly deteriorating due to constrained budgets, but more specifically the accumulation of deferred maintenance. The performance of the building aspect is directly influenced by the way the project is developed, designed, constructed and strategically planned. Therefore, it is strictly important to take action to plan and design better facilities. The purpose of this paper is to present the preliminary results of a research that will focus on the knowledge discovery from deferred maintenance.*

Keywords: Deferred Maintenance, Cost, Backlog, Construction, Higher Education. Life Cycle

I. INTRODUCTION

The physical inventory of public schools and universities is one of the greatest assets. The variety of programs these institutions offer, such as research and academic programs for students and university personnel, require a high performance building for a quality learning experience. Most of these facilities play a significant role in providing shelter, security, and endless resources for the users (Sadeghi, 2017). They are extremely complex in the interaction between their design and systems, requiring a continual and proper care in order to remain functional and safe. The life cycle cost for a facility from conceptualization to disposal is always difficult to determine and should be considered on the budget at the beginning of the project (Kasier 2006). For instance, Different people involved in the construction industry like main contractors, subcontractors and dozens of material suppliers works at different organizations (Karami, 2018). As a result, deferred maintenance in educational buildings across the United States is a growing concern because of inadequate investment, which leads to a major need for renovation and repair. The present conditions in multiple facilities and infrastructure in the higher education physical plants is worrying and alarming. In a study by the APPA on the issue shows that a $26 billion were spent on deferred maintenance, of which $5.7 billion are immediate needs (Lavy 2012).

In 2005 America's school infrastructure received a D grade by the American Society of Civil Engineers (ASCE) in their "Report Card for America's Infrastructure (Uline et. al., 2008). While this is a positive improvement from the D- and F grade in previous years, there still needs to be drastic improvements (Sadeghi, 2014). The health impact on students of schools in need of repairs has also been a factor throughout America. In Boston, poorly maintained schools with high rates of leakage, pest infestations, and mold, were found to have higher asthma rates for students (Graham, 2006). These negative impacts placed on students are more drastic than the amount of attention they have lately received. In the fall of 2016, 50.4 million students will attend public elementary and secondary schools (U.S. Department of Education, 2016).

With this in mind, it is crucial to identify the cause and take measures to quickly improve the situation. Unfortunately, the industry is rampant with several unethical practices such as: Insufficient training, an inadequate pipeline of new labor, and the lasting effects of the recession cause that construction industry will face workforce shortage, which has a negative effect on the delivery coast and completion time (Escamilla, 2016). By using Virtual Project-Based Simulation Game, workforce could be trained (Pariafsai, 2016). However, this mean has some flaw such as technical difficulty like low speed and limit options (Pariafsai, 2016). Also, other activities such as handle bulky and heavy standard materials and store at the site, increase

the potential accident and injuries (Escamilla). Storing fragile material like glasses, Glass has been used in construction since approximately 2000 years ago (Pariafsai, 2016), exacerbate this issue. Other factors influencing productivity are project environmental conditions and labor arrangements (Khanzadi, 2011). Educating the future generations is a critical desire for every society, therefore, it is crucial that the learning environment for schools are placed with the utmost importance (Sadeghi, 2012). A school where both students and faculty struggle with various issues such as noise, temperature control, and air quality is not likely to be conducive. For instance, using double skin facades to save energy and approaching green architecture (Mehdizadeh, 2014). While it is important that a school does not deter from investing in the maintenance of its facility, it is also important to find suitable staff, such as maintenance workers and custodians, in order to prolong building conditions (Lateef 2012). This issue needs to also be scrutinized in order to improve the current conditions of this nation's school facilities.

II. Deferred Maintenance on Higher Education Existing Buildings

Deferred maintenance can turn into a vicious cycle. When funding is limited, the list of postponed repair and maintenance can become very long. Projects that are put on hold, repair that is neglected, and preventive maintenance that is ignored, adds up to a costly and complex problem (Sadeghi, 2015). Due to the decay and deterioration of higher education facilities, current research is focused on improving present conditions (Wireman 2006). It is no secret that many colleges and universities are in rough shape, and for some, the problems are noticeable: outdated windows, leaking roofs or even cracking and spalling masonry.

In recent years, however, the issue has gotten worse. Sightlines, a consulting company that tracks and analyzes facilities issues at more than 400 colleges, has analyzed data from its member institutions and come to the conclusion that 2009 represented the "good old days" of capital investments in existing space (Heldenfels 2012). Conditions assessment, monitoring, analysis, and decision tools are areas that are highly populated with researchers. Researchers use a predictive type of maintenance that is reaction based; maintenance and repair are determined by monitoring measurements.

Though preventive and predictive maintenance may be perceived as a proactive approach, researchers are working within a framework that is naturally reactive (Lind 2012). When the facility is in the operations and maintenance phase of its life cycle, the inherent characteristics established in planning and design are reacting to its environment. Therefore, it is crucial to take a proactive approach to plan and design better facilities. Moreover, learning what factors led to present conditions will help to prevent future projects from experiencing similar results, and learning from good examples will benefit future facilities. The process of uncovering these factors involves the advancement of information technology which provides opportunities to investigate the factors that influence operations and maintenance (Wright 2012).

III. Cost

Costs relating to campus expansion, maintenance, and deferred maintenance have increased significantly over the past five years (Carlson, 2009). Facilities are second behind personnel in campus expenditure, but utilities, renewal costs, and and maintenance can compose about 70 percent of the lifetime costs of a building (Carlson, 2009). Deferred maintenance are closely related with inflation and the costs of construction materials (Crowley, 2008). Public universities and colleges in Ohio are facing a multi-billion-dollar backlog, all with construction needs. There is 37.2 million square feet of education-related space in Ohio, and the cost for rebuilding or remodeling is estimated at $3.9 billion to $5 billion (Crowley, 2008). In order for a university to fulfill this demand, they must withdraw money from other priorities throughout the university. The total deferred maintenance of schools in the United States was estimated at $254.6 billion in 2008 (Bello, M. and Loftness, V., 2010). One of the main reasons for this is because the portions of the funds received by the schools for maintenance are then deferred, which in turn result in poorly maintained school facilities. Costs relating to campus expansion, maintenance, and deferred maintenance have increased significantly over the past five years (Betts, 2009). The reason for this is because school and universities don’t realize the enormity of this issue, and therefore, they just push it to the back, into areas of less importance.

For over more than 20 years, different organizations, public and private, have looked at the deficiencies in school infrastructure and have come up with a wide range of estimates on how much it would cost to bring education facilities into good condition (Behn 2008). Although the numbers vary, the findings had this in common: The money that was being allocated to address the problem was inadequate, and the problem would become only worse as buildings continued to wear out and break down. Costs to operate, maintain and repair old buildings that are in poor condition increase every year. As the buildings get older and continue to deteriorate, the more it costs to maintain buildings from falling into further disrepair (Lenington 2006).

IV. Educating Society on Deferred Maintenance

As building maintenance continues to be deferred on academic campuses, building conditions continually decline more and more each year. For educational buildings, resources and assets must be well kept, in working condition and more importantly safe. By deferring maintenance perpetually these buildings may fall beyond the chance of renovation and into building failure. The Council of Great City Schools, a coalition of 67 large city districts fights to help administrators by educating them about the true cost of deferred maintenance. In their 2014 yearly report the council declared their new plan of "Reversing the cycle of Deterioration in the Nation's Public School Buildings" (Kennedy 2015). The purpose of their new plan is to promote education about deferred maintenance and implement newer actions to hold all faculty members accountable for routine maintenance. The Council requires that all administrators and faculty members participate, by electing leaders responsible for maintenance reports and proper allocation of resource strictly for routine maintenance. The Council has taken their actions another step further by hiring facility managers to professionally assist these schools by making proper budget choices, "In order… to make prudent planning and budgeting decisions, it is imperative to first select the right product" (Kennedy 2015) the report further explains this by stating "Purchasing the least expensive piece of equipment may initially be alluring; however over, the life of the building that decision may cost considerable more than a higher-quality piece with a greater initial cost". By hiring these facility managers, the council has eased the need of routine maintenance into these school districts by placing a professional in charge and preventing the school administrators from becoming overwhelmed. The Council's pressure to eliminate deferred maintenance has made a large impact within their school districts, by holding peers accountable to routine maintenance and hiring professionals to create an efficient plan.

When the workplace is in poor condition it is obvious, and the quality of the work directly reflects the quality of the workplace. The National Institute of Building Sciences (NIBS) performed a study, which concluded that "poor building conditions definitely negatively impacted teaching and learning" (Payton-Jones 2014). The quality of the students work should be the main concern of the administrators, and profound institutions such as the NIBS carry a large voice when making statements like this. Furthermore, Willison College of Pennsylvania recently had their library collapse during the school year which brought great attention to the need to end deferred maintenance. President Mistik of Wilson College, stated that "deferred maintenance that you let go will make itself an emergency" (Biemiller 2015). In comparison, whether it is a profound statement or a potentially harmful building failure the need to eliminate deferred maintenance is surely becoming prevalent. Between educating the administrators and sharing eye opening information with the public, deferred maintenance has become a primary concern in our educational systems.

V. Conclusion

Facilities are deteriorating everyday in higher education physical plants, as current research focuses on acquiring and analyzing data to improve constructed facilities. This data can be also used to generate knowledge that can impact the way facilities are planned and designed. The ability to influence a facility's life cycle cost is highest in the beginning of the project. As more data is being acquired, better processes are needed to not only transfer data into information, but into knowledge that can be applied throughout the lifecycle of a facility. Deferred maintenance in educational buildings throughout the United States needs no longer to be set aside. This concern still has detrimental impacts on the education of today's youth within public schools, even though the trend has gradually become positive in recent years (O'Sullivan, 2006). Educating schools and universities about this issue will hopefully enlarge this trend to produce a more proficient result.

Educating higher education institutions about the problems faced by deferred maintenance is important, so they can address and plan for the maintenance needed in the future. The University of Virginia has already requested to address the problem by reducing the backlog over the next ten years and establish annual maintenance funding to protect their facilities (University Budget Office 2005). They intend to improve their facilities from "poor condition" to "good condition", propose to facilitate major maintenance projects by establishing a major repair and renovation reserve to fund those projects, and also by prioritizing the renovation of buildings over new building construction. According to article, The University of Delaware also took action once seeing the facilities needed to be serviced again. Over a 13 year period, they estimated, planned, and were careful on how they spent their money in order to have surplus at the end of each year. The money was redirected to repairs, renovations, in which they spent $555-million, and the construction of 20 buildings (June 2003). Universities need be aware of the problem and should start addressing them. It is crucial for building administrators to take action on the issue and ensure a planned budget on maintenance and renovations needed for higher education buildings.

REFERENCES

[1] Abramson, P. (1997). Is Deferred Maintenance Putting Your College at Risk?. *College Planning & Management*, *1*(1), 32-36.

[2] Arsen, David, and Thomas Davis. "Taj Mahals of decaying shacks: Patterns in local school capital stock and unmet capital need." *Peabody Journal of Education* 81.4 (2006): 1-22

[3] Behn, R. D. (2008). Leadership for cut-back management: The use of corporate strategy. *Public Administration Review*, *40*(6), 613-620.

[4] Bello, Mustapha A., and Vivian Loftness. "Addressing Inadequate Investment in School Facility Maintenance." (2010).

[5] Betts, Kristen, Kenneth Hartman, and Carl Oxholm III. "Re-examining and repositioning higher education: twenty economic and demographic factors driving online and blended program enrolments." Journal of Asynchronous Learning Networks 13.4 (2009): 3-23.

[6] Biemiller, L. (2015). For Small Colleges, Some Maintenance Can No Longer Be Deferred. Chronicle Of Higher Education, 62(4), 25.

[7] CARLSON, S. (2012). How the Campus Crumbles: Colleges Face Challenges From Deferred Maintenance. Chronicle Of Higher Education, 58(37), A26-A27.

[8] CARLSON, S. (2013, November 15). Colleges Face Hard Choices as 'Deferred' Maintenance Gets Deferred Again. Chronicle of Higher Education. p. A24

[9] Carlson, Scott. "As Campuses Crumble, Budgets Are Crunched." The Chronicle of Higher Education 37.15 (2008): A1.

[10] Community College Week, June, A. W. (2003). More Than Just Maintenance. Chronicle Of Higher Education, 50(7), A27.

[11] Crowley, P. "As universities age, billions-worth of projects on table" in Business First of Columbus, 2008.

[12] Ed, Maintenance., Page 10 2 Of, and University Office Budget. University of Virginia Addressing the University's Deferred Maintenance Backlog (n.d.): n. pag. Web.

[13] Escamilla, E., and M. Ostadalimakhmalbaf. "Capacity Building for Sustainable Workforce in the Construction Industry." The Professional Constructor 41.1 (2016): 51-71.

[14] Escamilla, Edelmiro, Mohammadreza Ostadalimakhmalbaf, and Ben F. Bigelow. "Factors impacting Hispanic high school students and how to best reach them for the careers in the construction industry." International Journal of Construction Education and Research 12.2 (2016): 82-98.

[15] Escamilla, Edelmiro, Mohammedreza Ostadalimakhmalbaf, and Anusree Saseendran. "Hispanic Workers: Identification of Factors Impacting Fatal and Non-Fatal Injuries in the US Construction Industry."

[16] Falling Behind: School Maintenance & Operations. (n.d.). Retrieved September 20, 2016, from http://m.asumag.com/deferred-maintenance/falling-behind-school-maintenance-operations?page=2

[17] Frazier, L. M. (1993). Deteriorating school facilities and student learning.

[18] Graham, T.; Zotter, J. and Camacho, M (2006): Who's sick at school? : Linking poor school conditions and health disparities for Boston's children; Boston, MA.

[19] Heldenfels, F. W. (2012, January). Summary of Deferred Maintenance Needs. Summary of Deferred Maintenance Needs, 1-14. Retrieved September 20, 2016, from http://www.thecb.state.tx.us/reports/pdf/2421.PDF

[20] June, A. W. (2003). More than Just Maintenance. Chronicle Of Higher Education, 50(7), A27-A28

[21] June, A. W. (2003). Over 13 Years, a University Moves From Deferred to Scheduled Maintenance. Chronicle Of Higher Education, 50(7), A28.

[22] Kaiser, H. H., & Davis, J. S. (2006). A Foundation To Uphold: A Study of Facilities Conditions at US Colleges and Universities. APPA: Association of Higher Education Facilities Officers, 1643 Prince Street, Alexandria, VA 22314-2818.

[23] Kaiser, H. K. (1997). Capital renewal and deferred maintenance programs. Association of Higher Education Facilities Officers.

[24] Karami, Z., & Danesh, M. (2018). Developing A Web-Based Application for Accelerating Data Management: Construction Materials Section.

[25] Kennedy, M. (2000). MAINTENANCE DEFERRED. American School & University, 73(4), 34B

[26] KENNEDY, M. (2015). Denting Deferred Maintenance. American School & University, 87(8), 25-26.

[27] Khanzadi, Mostafa, et al. "Selecting the best strategy of labour productivity improvement in Tehran grade 1-3 construction contractor companies by applying analytic hierarchy process and statistical analysis of effective factors on labour productivity." The International Symposium on the Analytic Hierarchy Process (ISAHP), Sorrento (Naples). 2011.

[28] Lateef, O. A. (2010). Case for alternative approach to building maintenance management of public universities. Journal of Building Appraisal, 5(3), 201-212.

[29] Lavy, S. (2008). Facility management practices in higher education buildings: A case study. Journal of Facilities Management, 6(4), 303-315.

[30] Lavy, Sarel, and David L. Bilbo. "Facilities maintenance management practices in large public schools, Texas." Facilities 27.1/2 (2009): 5-20.

[31] Lavy, Sarel, John A. Garcia, and Manish K. Dixit. "KPIs for facility's performance assessment, Part II: identification of variables and deriving expressions for core indicators." Facilities 32.5/6 (2014): 275-294.

[32] Lavy, Sarel. "Facility management practices in higher education buildings: A case study." Journal of Facilities Management 6.4 (2008): 303-315.

[33] Lawrence, B. K. (2003). Save a Penny, Lose a School: The Real Cost of Deferred Maintenance. Policy Brief Series on Rural Education.

[34] Lenington, R. L. (2006). Managing Higher Education as a Business. Oryx Press, 4041 North Central at Indian School Road, Phoenix, AZ 85012-3397.

[35] Lind, H., & Muyingo, H. (2012). Building maintenance strategies: planning under uncertainty. Property Management, 30(1), 14-28.

[36] Lind, H., & Muyingo, H. (2012). Building maintenance strategies: planning under uncertainty. Property Management, 30(1), 14-28.

[37] MEHDIZADEH, S. F., DANESH, M. M., & SANAYEAYAN, H. (2014). THE EFFECTS OF INNER AND OUTER LAYERS OF DOUBLE GLAZED FACADE ON THE RATE OF ENERGY CONSUMPTION IN OFFICIAL AND EDUCATIONAL BUILDINGS (CASE STUDY: IRAN UNIVERSITY OF SCIENCE AND TECHNOLOGY).

[38] O'Sullivan, Sean. A study of the relationship between building conditions and student academic achievement in Pennsylvania's high school. Diss. Virginia Polytechnic Institute and State University, 2006.

[39] One Step at a Time: How to Escape the Deferred-Maintenance Spiral. (2013). Presidency, 1-3

[40] Pariafsai, Fatemeh. "Effectiveness of a Virtual Project-Based Simulation Game in Construction Education." International Journal of Scientific Research in Science, Engineering and Technology (IJSRSET) 2.5 (2016): 377-393.

[41] Pariafsai, Fatemeh. "Students' View on Potential of a Project-Based Simulation Game for Construction Education." (2016).

[42] Pariafsai, Fatemeh. "Strengths & Weaknesses of a Project-Based Simulation Game as an Educational Tool." (2016).

[43] Pariafsai, Fatemeh. "A review of design considerations in glass buildings." Frontiers of Architectural Research 5.2 (2016): 171-193.

[44] Payton-Jones, K. (2014). A Matter of Time: Perspectives on Deferred Maintenance. (Cover story). American School & University, 87(2), 12-15.

[45] Report Finds Aging Institutions Need $50M in Deferred Maintenance. (2015). Community College Week27(18), 44.

[46] Asl, V. M., Sadeghi, S. A., & Fathi, S. (2012). A mathematical model and solving method for multi-depot and multi-level vehicle routing problem with fuzzy time windows. Advances in Intelligent Transportation Systems, 1(1), 19-24.

[47] Sadeghi, S. A., & Karava, P. (2014). Stochastic model predictive control of mixed-mode buildings based on probabilistic interactions of occupants with window blinds.

[48] Sadeghi, S. A. (2015). Integration of Occupant Interactions with Window Blinds on Model Predictive Control of Mixed-Mode Buildings. ASHRAE Transactions, 121, 1VV.

[49] Sadeghi, S. A., Awalgaonkar, N. M., Karava, P., & Bilionis, I. (2017). A Bayesian modeling approach of human interactions with shading and electric lighting systems in private offices. Energy and Buildings, 134, 185-201.

[50] Sheets, Martin Eugene. "The relationship between the condition of school facilities and certain educational outcomes, particularly in rural public high schools in Texas." (2009).

[51] U.S. Department of Education, National Center for Education Statistics, Common Core of Data (CCD), "State Nonfiscal Survey of Public Elementary and Secondary Education," 1990-91 through 2013-14

[52] Uline, Cynthia, and Megan Tschannen-Moran. "The walls speak: The interplay of quality facilities, school climate, and student achievement." Journal of Educational Administration 46.1 (2008): 55-73.

[53] WILLIAMS, J. A. (2003). OVER 13 YEARS, A UNIVERSITY MOVES FROM DEFERRED TO SCHEDULED MAINTENANCE. Chronicle of Higher Education.

[54] Wireman, T. (2006). Developing performance indicators for managing maintenance. Industrial Press Inc..

[55] Wright, T. S., & Wilton, H. (2012). Facilities management directors' conceptualizations of sustainability in higher education. Journal of Cleaner Production, 31, 118-125.

[56] Zusman, A. (2005). Challenges facing higher education in the twenty-first century. American higher education in the twenty-first century: Social, political, and economic challenges, 2, 115-160