ASEE's 123rd Annual • Conference & Exposition • New Orleans, LA • June 26-29, 2016

Paper ID #14476

Educating Construction Engineering and Management Students Through Real University Projects

Dr. Carla Lopez del Puerto, University of Puerto Rico - Mayaguez

Carla Lopez del Puerto, Ph.D., Associate Professor Construction Engineering and Management Department of Civil Engineering University of Puerto Rico at Mayaguez email: Carla.LopezdelPuerto@upr.edu http://cem.uprm.edu

Dr. Omar I. Molina-Bas, University of Puerto Rico - Mayaguez

Omar I. Molina Bas, Ph.D. Associate Professor and Unit Coordinator Construction Engineering and Management Department of Civil Engineering and Surveying University of Puerto Rico, Mayagüez Campus email: omar.molina1@upr.edu http://cem.uprm.edu/molina.html

Ing. Darwin Serrano Maldonado, University of Puerto Rico

Darwin Serrano Maldonado Graduate Student Construction Engineering and Management Department of Civil Engineering University of Puerto Rico at Mayaguez email: darwin.serrano@upr.edu http://cem.uprm.edu

Educating Construction Engineering and Management Students Through Real University Projects

In recent years there has been an increased concern over the insufficiency of funds to adequately maintain campus infrastructure. The funding requirements needed to remodel existing campus buildings and build new facilities are not keeping pace with the number of students enrolled in public universities and their needs. In order to satisfy the demand and provide educational facilities to create an environment that is conducive to learning, universities are having to search for innovative solutions for their campuses. This paper explores the involvement of Construction Engineering and Management (CEM) graduate students to assist in the pre-construction phase of university projects. The pre-construction phase includes all the work required to develop construction documents starting at the conceptual phase and ending at the point where the construction contract can be awarded. Having graduate CEM students working in real university projects benefits the university by lowering the costs that they would ordinarily incur by either having their architecture/engineering team and facilities maintenance staff or outside consultants working in the pre-construction phase of a project. It benefits CEM faculty who supervise the graduate students because it provides them relevant and current experience working on projects and an opportunity to interact with campus administrators and personnel outside their department. Finally and arguably most important, it benefits CEM graduate students by providing them a meaningful experience to participate in projects that have the potential to be built on their campus. This paper presents two solutions that were developed by CEM graduate students to address specific infrastructure needs at a land-grant university. The first solution involves a feasibility study to determine the amount that university students would be willing to pay to build a parking garage through a Public-Private-Partnership. This solution also includes a conceptual design of a solar energy sculpture that aims to blend art and technology to raise awareness about renewable energy. The second solution involves a conceptual design of a new space for a Building Information Modeling (BIM) lab. This paper contributes to the body of knowledge by highlighting specific projects that have benefited from CEM graduate student involvement and discussing ways to make student involvement in university projects more efficient and beneficial for all parties involved while managing risk.

Introduction

In order to provide students with the best possible education, educational institutions must allocate their financial resources appropriately to ensure that facilities enjoy a long life and provide a reasonable return of investment to the institution[1,2]. Most universities have a General Services department that is responsible for providing the management and professional services required to renovate existing campus infrastructure and build new facilities to meet the needs of their students, faculty and staff. General Service's personnel act as owner's representatives and are responsible for identifying infrastructure needs in conjunction with campus administrators. General Service's personnel also procure consulting services, coordinate the bidding process and manage contracts with designers and contractors among other responsibilities[3]. The increase in student enrollment, increase in awareness of the benefits of sustainable building and decrease in funding has put

general service departments in a tough position. On one hand, the need for adequate and sustainable campus infrastructure continues to grow. On the other hand, there is a lack of funding to hire additional facilities management personnel to meet the growing demand. General Service's personnel often have a large backlog of projects and lack the funds to hire additional personnel or outsource the work. This forces campus administrators and facility management personnel to look for alternative solutions to satisfy the needs of campus users.

General Service's personnel are typically responsible for Pre-Construction Services (PCS). PCS consist of all the work completed on the project from the conception through the contract award. It includes activities such as conceptual design, feasibility studies, preliminary engineering, and many other activities until there is enough information about the project that design and construction professionals can be hired[4]. This paper explores the involvement of Construction Engineering and Management (CEM) graduate students to assist General Service's personnel in the pre-construction phase of university projects.

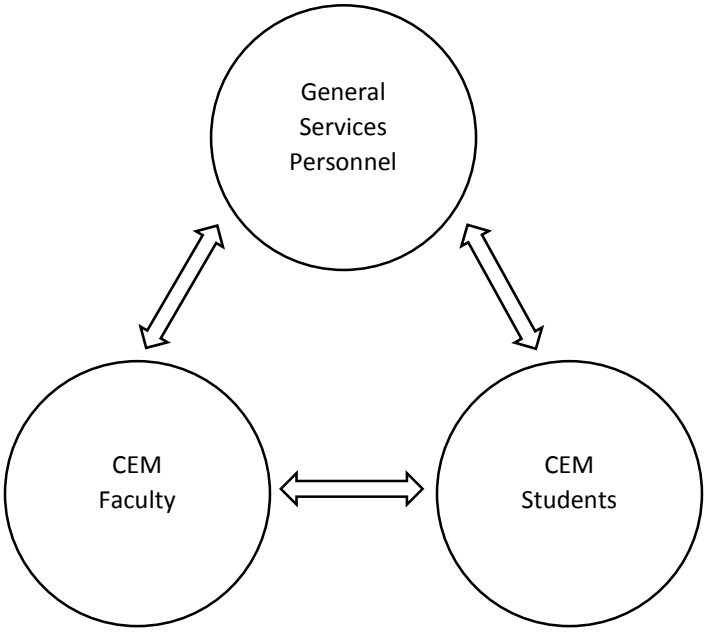
According to the United States Green Building Council (USGBC), in recent years the sustainable construction sector has grown exponentially as architects, engineers, public and private owners and the general population realize the health, environmental and financial benefits of green buildings[5]. While most university see the benefits of building sustainable projects on their campuses, universities often struggle to find funding for such project and construction projects in general.

Many university systems have sought alternative and creative solutions to be able to provide adequate campus facilities with a limited budget. Several universities have renovated or built new buildings and infrastructure with Private Public Partnerships (PPP). Those organizations are continuing the example of the government, looking for private sector to maximize the private financing of the infrastructure[6]. The deficiency of funds is not the only reason to find alternatives for the growth of the infrastructure, also the transfer of risks to other sectors and the evolution of the private sector, makes a PPP a more common solution to take. Public universities have been affected in the last years with the reduction in the government funds. The new state laws are applicable to the university and encourage the assessment of new alternatives methods to fix the infrastructure problem[7]. The utilization of alternative financial methods have been done by the Construction Engineering and Management (CEM) program to research and find alternatives to cover the high demand in the development of infrastructure.

A partnership between General Service's personnel, Construction Engineering and Management faculty members and graduates students was created to facilitate collaboration among the three parties involved. The partnering model shown in figure 1 can be beneficial to all parties involved. Having graduate CEM students working in real university projects benefits the university by lowering the costs that they would ordinarily incur by either having their architecture/engineering team and General Service's staff or outside consultants working in the pre-construction phase of a project. It benefits CEM faculty who supervise the graduate students because it provides them relevant and current experience working on projects and an opportunity to interact with campus administrators and personnel outside their department. Finally and arguably most important, it benefits CEM graduate students by providing them a meaningful experience to participate in

projects that have the potential to be built on their campus. The next step was for facility management personnel to provide a list of projects based on their needs for campus building and infrastructure expansions and renovations. CEM faculty analyzed the list and provided input regarding their areas of expertise and availability to collaborate on particular projects. Campus administrators provided their input and the following two projects, presented in this paper as case studies, were selected as the pilot projects: a parking garage and a Building Information Modeling lab.

Figure 1: Collaboration and Benefits Model Overview

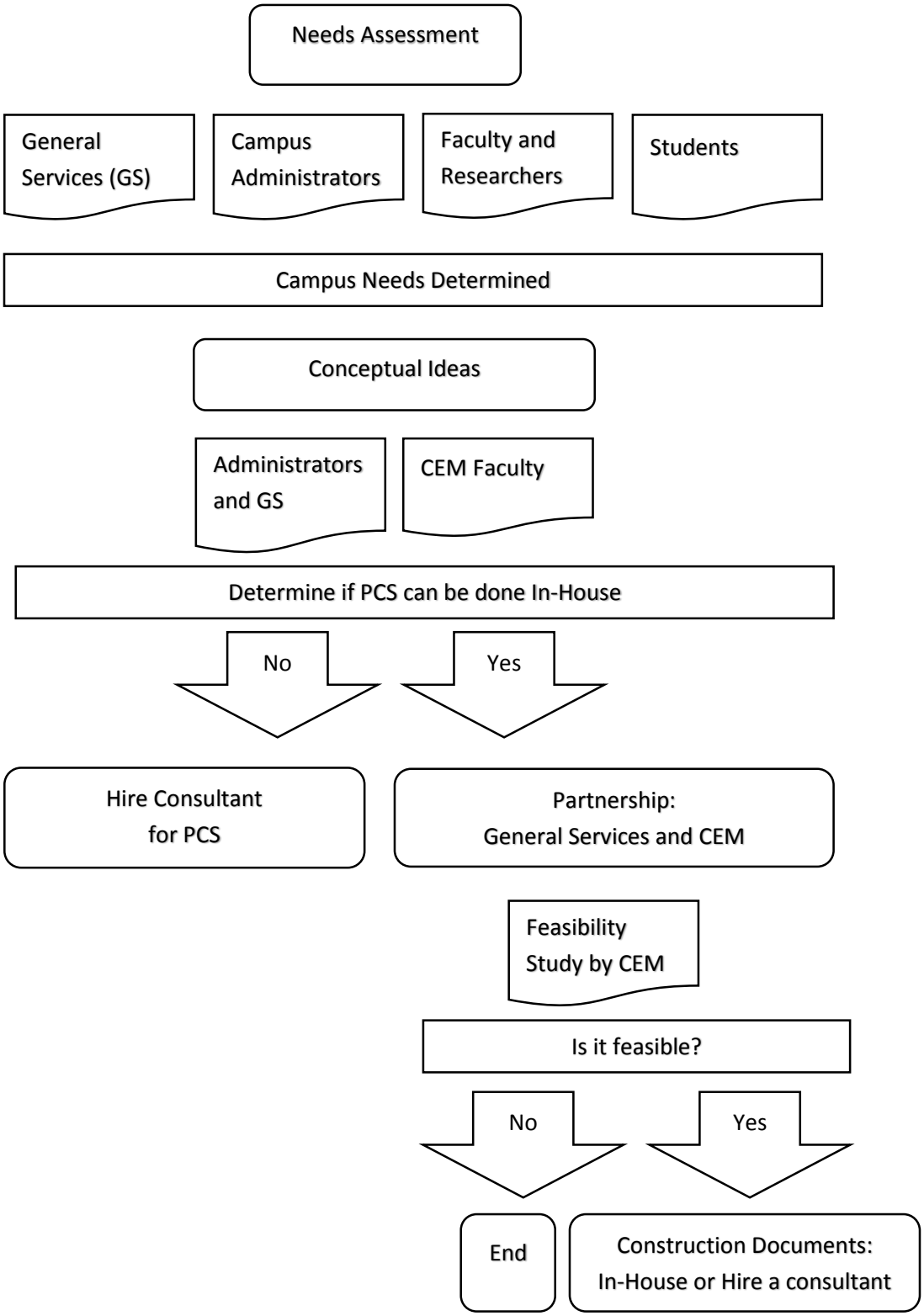


Methodology

This study involves a multi-step approach to determine in which projects graduate students in CEM can make a contribution. In the first step, campus administrators, particularly Dean's Offices and Departments conduct a needs assessment. Based on the results of the needs assessment, the conceptual ideas are developed (step 2). The conceptual ideas are used to investigate how the project will move forward. The two possibilities are to conduct the PCS in-house or to outsource it to a consultant. In order to determine if the study can be developed in-house with assistance of CEM faculty and graduate students, general service's personnel meet with CEM faculty and analyze it to investigate if their area of expertise matches the project and if they can identify students that may assist in the project. If the decision is made that CEM faculty and students can be involved, the next step is for CEM students to conduct the feasibility study with guidance from CEM faculty and general service's personnel. Campus administrators, faculty deans, departments chairs, professors, and researches, periodically review the progress and provide feedback. Once the feasibility study is completed, if the project is feasible, the project can be designed "in-house" or it can be outsourced to a design professional (architects/engineers) to complete construction documents that are required for contractors to bid the project. See Figure 2. This research investigated the following questions: Can CEM graduate students be systematically involved in

real university projects to assist General Services in improving campus infrastructure while reducing project costs related to PCS? Do CEM graduate students benefit from being involved in real university projects?

Figure 2: Methodology Flowchart



Case Studies

Case Study #1: Parking Garage

Student parking on campus has been challenging for a long period of time due to the increase in student enrollment and the fact that the main parking lot is located in an area that is prone to flooding. Currently, students are allowed to park on flooding prone areas but an email goes out the community if significant rain is expected so that their vehicles can be moved. This causes disruptions from classes as students often leave in the middle of class to move their vehicles and due to lack of parking availability they often do not return to class. In order to solve the problem, a multistory and multiuse parking structure is needed to replace the number of parking spaces that are currently in the flooding prone area, shown in Figure 3.

Figure 3: Proposed parking garage location[8]

The economic crisis in Puerto Rico has reduced the amount of funding that the university receives and has also limited its borrowing capacity. This situation makes building a parking garage using university funds unfeasible. An alternative solution is to build the parking garage using a Public Private Partnership (P3 or PPP).

Campus administrators are concerned about the acceptance by the community of using private funds on a public university. Misconceptions by the community often lead to strong opposition since they wrongly believe that P3 are privatizations. In order to put the concerns to a rest, CEM graduate students developed and administered a student community acceptance survey. The survey consists of 21 questions and includes information about P3 so that students can understand the delivery method and can make an educated decision regarding whether or not it would be an appropriate solution.

In an effort to highlight the use of solar energy while providing an outdoor space for students to work and charge their electronic portable devices, a solar energy sculpture will be included in the green area adjacent to the proposed parking garage. The goal of the project is to provide a solar energy sculpture that blends art with solar energy technology in an artistic expression. The sculpture acts as a focal point for recreation and shelter from the sun and rain while making a statement about the importance of using alternative energy sources.

Survey Results

The survey was completed by 1,000 students out of the 12,000 students enrolled on campus. This allowed us to have a representative sample of the students' perceptions, beliefs and misconceptions regarding building a new parking garage. The survey asked students about their knowledge and opinions about using alternative financing sources, their opinion and willingness to pay a parking fee (parking is currently free for all users on campus), and types of commercial services that they would like to see offered if a mixed use building that consisted of parking and commercial space was to be built.

The survey results show that 74% of students are willing to pay a fee for parking if it means that they will have less trouble finding parking spots for their vehicles. The results also show that the majority of students (78%) support the use of P3 as an alternative funding solution. Based on the results of the survey, the partnership decided to continue with the feasibility study to develop a conceptual design for the project. The conceptual design includes 950 parking spaces and 50,000 sf of commercial area that will be leased and the income would reduce the parking fee that students would pay. The cost of the project is estimated to be around $26 Million. Based in the results of the survey, assuming that students pay a parking fee of $50 per semester and that 80% of the commercial space is leased, the payback period for the project would be 21 years. We believe that this is an attractive payback period for investors and a feasible solution for the current parking challenges that the university faces.

Benefits

CEM graduate students involved in the project benefited by increasing their knowledge about a current challenge in their campus community and finding alternative solutions to alleviate the problem. They also benefited by interacting with campus administrators and facility management personnel which was similar to the interaction that they would have with a client in their professional careers. They also increased their knowledge about P3, feasibility studies and the empowered the community in the decision making process of investigating if a multistory parking garage using a P3 is acceptable and feasible. The university benefited by having a better idea about its students' perceptions and opinions of using alternative funding sources and the feasibility of building a new parking garage on their campus.

Case Study #2 Building Information Modeling (BIM) lab

In order simulate the professional work environment where students will work once they graduate from their university program, a partnership was formed between the Construction Engineering

and Management program and the School of Architecture. The partnership aspires to create interdisciplinary teams that allow students in CEM and architecture to integrate the knowledge acquired during their studies to solve real life problems. Students are divided into teams that consist of both architecture and CEM students

The project that was selected for the course was an expansion to the Civil Engineering building which is in line with the purpose to creating a partnership with facilities management to assist with solutions to real university problems. The architecture students were responsible for providing conceptual and preliminary designs and CEM students were responsible for developing the cost estimate and schedule. All students were responsible for ensuring that the expansion was in compliance with the current Building Code and that the renovation was design and built to achieve LEED certification.

The collaboration effort required virtual meeting as well as physical meetings with students in their discipline. The School of Architecture in currently has a state of the art lab that was used by its students but the CEM program lacks an adequate dedicated space for this purpose. The first time that the course was offered, it was offered in a regular classroom which posed many technological challenges and was not conducive to learning. Graduate CEM students were asked to evaluate the current classroom set-up and identify space and technology needs based on the first time that the course was offered and student work preference. Having students assist us in identifying the needs will allow us to build a BIM lab that meets their needs. A graduate student is currently assisting in developing the design, cost estimate and schedule for the lab.

Conclusions

This paper explored using real university projects to provide construction engineering and management students a meaningful experience by participating in projects that have the potential to be built on their campus while assisting facilities management in the pre-construction phase of the projects. The involvement of construction engineering and management students reduces administrative costs to the university while enhancing the projects. The case studies show that CEM students can be systematically involved in real university projects to assist General Services in improving campus infrastructure. Having professionals and students with diverse backgrounds and at different stages in their careers benefits the project by having a more comprehensive input than they would have if only facilities management personnel were involved. The use of surveys to investigate whether or not a project is feasible and accepted by the campus community assist campus administrators in their decision making process when deciding to fund a project. The use of surveys to investigate user perceptions empowered the community to participate in the decision-making process. CEM students benefited from being involved in real university projects. The construction engineering and management faculty who are involved in the projects benefit by gaining professional experience in from project conception and are able to apply the construction engineering management theory to practice. Faculty also are able to use the project as examples when explaining construction management concepts in their courses.

References

1. Bennett, S. (2007). Designing for uncertainty: Three approaches. The Journal of Academic Librarianship, 33(2), 165-179.
2. Hearn, J., Lewis, D., & Kallsen, L. (2006). Incentives for managed growth: A case study of incentives-based planning and budgeting in a large public research university. Journal of Higher Education, 77(2), 286-316.
3. Design and Construction, n.d. http://www.colorado.edu/fm/planning-design-construction/design-construction
4. Gransberg, D.D., Jeong, H.D. and Hunter, K.D., Preconstruction Services Estimating Guidebook, Interim Research Report, NCHRP Project 15-51, 2014, 149pp.
5. USGBC, n.d., http://www.usgbc.org.
6. Grimsey D, Lewis MK. Public Private Partnership, the worldwide revolution in infrastructure provision and project finance. Northampton: Edward Elgar; 2004.
7. UPR Diálogo (2010): "Acciones establecidas para recortes presupuestarios" http://dialogoupr.com (Jan. 25, 2016)
8. UPRM Map, n.d., http://www.uprm.edu/p/sobrenosotros/mapa_del_recinto
9. Perdomo, J., Cavallin, H. (2014). Transforming Building Design Through Integrated Project Delivery in Architectural and Engineering Education, Proceedings of the ASCE 2014 Construction Research Congress