Creative Construction Conference 2016

Reducing Operational Costs for Inherited Buildings: Case Study of a Women's Shelter at the End of its Life Cycle

Keith A. Rahn[1]*, Kasie Elston[2]

[1] *Auburn University, 222 Gorrie Center, Auburn, Alabama, 36849, USA, kar0023@auburn.edu*
[2] *Auburn University, 118 Gorrie Center, Auburn, Alabama, 36849, USA, kle0004@auburn.edu*

Abstract

Obstacles faced when utilizing adaptive reuse for an old building located in a poverty-stricken high-crime area are numerous. This study evaluates the effectiveness of adaptive reuse and recommends best practices for facility operation and maintenance. To evaluate the effectiveness of adaptive reuse in the case of a women's shelter, the investigators used five data collection methods: literature review, building assessment, resident surveys, staff interviews and utility record analysis. This research revealed that the shelter did not choose the most effective facility to adapt and reuse for their growing needs. The facility meets the basic necessities of the shelter; however, sustainability of this adaptive reuse effort remains poor. High utility costs, excessive repairs, and several opportunities for heat loss in the building have severely reduced operational efficiency and prevented optimal use of funding to benefit women in need. Structure analysis combined with expected need would better serve those embarking on a project to effectively utilize a preexisting building to its optimal potential rather than building new to exact specifications.

Keywords: adaptive reuse; construction; cost; operational cost; sustainability

1. Introduction

The women's shelter is surrounded by the city transportation department, a museum, an elementary school, a few small restaurants, and convenient stores. The building is located in a poverty-stricken high-crime metropolitan area. It is an adaptive reuse facility with building repairs in excess of $100,000 and counting. Most of the women who have needed the assistance of this shelter in the past have been senior citizens experiencing homelessness. The facility depends primarily on donations; however, even with the donations they receive, high utility costs limit the impact of funding and the potential to effectively benefit a greater number of women requiring basic shelter needs.

The shelter failed to assess significant structural considerations in view of the current facility for the intended purpose when it was inherited. Failure to recognize the key considerations in analyzing and assessing the deterioration of the structure have adversely affected both staff and those seeking refuge within the shelter. Reducing operational costs by further analysis of the current structure would aid in development of a cost savings plan as well as pinpoint other needs not otherwise considered. This would lend itself to a proactive situation rather than the current reactive approach utilized by residents and staff. The shelter could potentially reduce their operational costs by effectively assessing the building and implementing a structured adaptive reuse approach. Specific strategic modifications could potentially reduce building maintenance and operation costs creating increased opportunities for growth and wellbeing.

* Keith A. Rahn. Tel.: +334-844-8261; fax: +334-844-5386.
*E-mail address:*kar0023@auburn.edu

2. Literature review

Common nomenclature used for adaptive reuse can be misleading. According to Holyoake and Wyatt [8], reuse can mean something special, unique, and often expensive while adaptation describes rehabilitation, renovation or restoration works that do not necessarily involve changes of use. Unlike restoration, adaptation does not restore a building to its original state, instead adaptation "retains as much as possible of the original building while upgrading the performance to suit modern standards and changing user requirements [9]." Adaptive reuse, as defined by Douglas [6], is any building work and intervention to change its capacity, function or performance and adjust, reuse or upgrade a building to suit new conditions or requirements.

With investment cost of renovations and repairs mirroring, and in some cases exceeding new construction investments, the design and construction industries are looking at a huge shift. Although there is still a demand for new construction, "the market is overbuilt;" therefore, most of the construction within the next decade will consist of renovations and adaptive reuse projects on the existing building stock [5]. Bullen [2] supports and highlights the fact that new construction only accounts for 1.5-2% of the existing building stock in developed countries. Within the next 25-years, the majority of the work procured will most likely include improvements on the existing building stock [1]. This trend is prompted and accelerated by the growing need to preserve natural resources and reduce energy use and greenhouse gas emissions [2].

According to Spector [10] as referenced by Bullen and Love [3], there are seven major considerations that should be factored into the decision-making process for adaptive reuse building selection. The suggested considerations include the following: Layout, Energy Efficiency, Potential Requirements, Condition, Hazardous Materials, Building Safety and Security, and Location [2]. There are several reasons that may propel an owner to prefer demolition as opposed to adaptation [3, 4]. These reasons include: "the building reaching the end of its service life; reduction of the building's usefulness over time; the building becoming out of fashion and out of date; deterioration of the fabric or structure; reduction in efficiency coupled with increased expenditure to keep the building operating; reduction in ability to meet the demands of occupants over time; population movements either increasing or decreasing; and prolonged vacancy rates [3]."

To increase a buildings viability for adaptive reuse, it is suggested that owners and stakeholders conduct an in depth analysis of the site, structure and shell, division of interior space, materials and components, technologies, archival documentation, style and durability of the building [1]. It has been proven that adaptive reuse is sustainable for the environment; however, the underlying concern that ultimately serves as a catalyst for people to buy into this concept is the financial costs of adaptive reuse projects. According to interviews conducted by Yung and Chan [12] "the economic viability of the new operating use has been the key hurdle to successful adaptive reuse. Compared to standard reuse projects, sustainable adaptive reuse projects tend to be 12% more expensive [7] yet "an adaptive reuse strategy is only preferable to demolition if the objectives of environmental sustainability and reduced energy consumption can be attained [11]."

Ongoing maintenance costs pose as one of the largest threats to the economic efficiency of a building and are a consideration that spurs owners to prefer demolition and reconstruction or new construction in lieu of adaptive reuse [3]. Likewise, every building is not suitable for adaptive reuse. In fact, "several architects suggested that buildings reach a point in their life where they cannot be adapted anymore and demolition is the only solution" [3]. When the intangible, though not easily measured, and tangible benefits of a project are found to be greater than the initial investment, economic efficiency is achieved [12].

3. Methodology

Both quantitative and qualitative data were collected during this study. The researcher employed five data collection methods to procure the following results and findings. Those methods employed included: literature review, building assessment, resident surveys, staff interviews, and utility record analysis. Direct inspection of the structure was completed. Interior and exterior components of the facility were assessed and included but were not limited to the windows, entryways, roof, mechanical systems, and organizational layout. Other considerations focused on heat loss with utilization of thermal imaging equipment to better identify specific areas of the building which negatively impact cost savings. The thermal imaging camera used was a Fluke® Ti32 (Everett, Washington – USA) selected for its accuracy, durability, portability, capability in both visible and infrared wavelengths, and on-screen emissivity correction and reflected background temperature compensation. Imaged data was analyzed by using the Fluke SmartView® 3.5 software. By analyzing the data obtained, the researcher was able to detect significant relationships between different variables and offer suggestions regarding potential areas to focus immediate attention in an effort to reap the most benefit for minimal cost.

4. Results and findings

4.1. *Shelter history*

According to the program director for the women's shelter, most of the buildings located on the shelter's campus were built in 1942. The main building, which houses all of the shelter's operations, was built in 1950. Originally, this campus served as the area's first low-income apartment community. The campus was then transformed into a place for disabled children of military families and temporary housing for the visiting military family members. Mental health purchased the property in the 1990s and the facilities were redefined as an establishment for the mentally ill. This transition resulted in the adaptation of several rooms into rooms functional for hospital care. When the government shut down 85% of the mental health facilities in Alabama, the facility was closed and the campus was vacant for one year. In 2013, the campus was purchased by a local church and transformed into a shelter for homeless women and their children.

The campus was purchased with the expectation that all buildings would be used to house homeless women and children. However, soon after the campus was purchased, the sprinkler systems malfunctioned and flooded several of the buildings. This accident caused tremendous damage to the buildings and hindered the staff from using the facilities to their full capacity. Currently, several of the buildings are either used for storage or are completely vacant and abandoned.

4.2. *Site observation*

The main building, the focus of this study, was oriented north to south. The front street-facing façade of the building faces north. Using Google Earth images, the researcher calculated the approximate square footage to be 16,200 square feet for the base level. The facility (Figure 1) housed 12 total apartments: two apartments used for single women, one apartment designated for onsite staff housing and the remaining nine apartments used to house single-mother families. In addition to these apartments, former medical-examination rooms were adapted and transitioned into overflow rooms for emergency situations and wait-listed applicants.

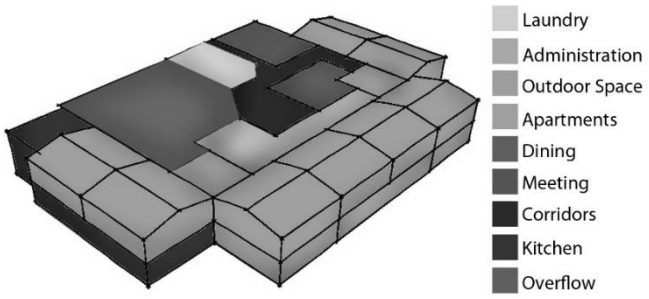

Figure 1. Interior Layout Diagram

The buildings are comprised of load bearing concrete masonry unit walls and a steel roof framing system clad with an array of materials including: aluminum, asphalt, and a rolled roofing material. Overall, the building looked worn on the exterior. The window systems were extremely dated single-pane systems with minimal caulking, several cracks and defects, and rust accumulation on the sills was observed.

The administrative areas included office spaces for the: case manager, assistant program director and the program director. These areas were located in the front of the facility and were high-traffic areas with usual activities like: donation drop-offs, resident arrival and departure, social activity and more. This space was often directly exposed to outside elements due to it being a high-traffic area. A community dining area also served as a place for residents to: eat, read or engage in other low-impact activities.

The multi-family communal aspect of the shelter posed difficulties for leadership in regards to maintaining physical organization. A lack of organization in the shelter negatively impacted operating efficiency. In the community room, chairs play pens, tables, and the like blocked active wall-mounted air returns. Damaged window treatments within the facility reduced the effectiveness of blocking the sunlight into the space. Uncontrolled light entered the building and solar heat gain for the space increased. Architectural defects in the building limited the effectiveness of the small organizational changes that needed to be made within the space. The building had several

window penetrations for pieces of outdated equipment like window air conditioning units. These units were inoperable and only served as opportunities for heat loss throughout the space.

Acoustical ceiling tiles were missing with this ceiling defect exposing old fiberglass batt insulation. Gapped insulation could be contributing to heat loss within the space as well. In conjunction with the window units and insulation problems, there were resident induced weaknesses in the facility. Residents utilized floor model fans throughout their rooms—some which had more than one portable fan. One resident explained that the room temperatures were occasionally too hot for some of her roommates so the fans were used to cool the space. Cables were wired through windowpane defects. In an attempt to reduce the draft that this unconventional wire routing may cause, the resident applied duct-tape to the window.

Thermal imaging of the main areas demonstrated heat loss near the perimeter of the building with an almost 10-degree temperature difference from the interior spaces to the perimeter spaces. Infiltration through the doors caused by the open space at the base of exterior doors, window glazing, exposed exterior duct work, inoperable window units and gapped insulation served as major areas of heat loss for the facility. Dated mechanical systems were not functional to meet the minimal load to effectively heat and cool the structure.

4.3. *Utilities*

4.3.1. Gas

For the gas bill, the records ranged from April 2014 to August 2015. Over this 16-month time period, the average gas bill totaled $576.99 ranging from a minimum of $217.17 to a maximum of $1,466.60. The maximum gas usage during this time period took place in the period ranging from December 2014 to January 2015 with 1319 (100's of cubic feet) used. The lowest gas bill was recorded in the billing period ranging from June 2015 to July 2015 with 169 (100's of cubic feet) used. Further analysis demonstrated gas usage increases while power usage decreases during the colder months and gas usage decreases while power usage increases during the warmer months. Furthermore, according to the weather history and the utility data, the following trends unveiled: on average, gas usage decreases by 53% on cooling degree-days whereas gas usage increases by 202% on heating degree-days. There are several factors to consider. The lower gas usage may be the result of fewer residents in 2015 as opposed to 2014, a change in equipment, and/or more efficient use of gas.

4.3.2. Water

The utility records for water were gathered for twelve consecutive months ranging from January 2014 to December 2014. During this time period, the average water bill for the shelter totaled $672.56 with an average water consumption of 93,250 gallons. The peak water usage occurred in January with water consumption reaching 112,000 gallons and the utility bill cost of $784.62. The least water usage occurred in the months of November and December 2014 with water consumption being 77,000 gallons and the utility bill cost of $576.41. There seemed to be no apparent trends in water usage for the women's shelter no significant relationship between water and electric. A significant relationship between water and gas may be present in the shelter and this could be attributes to the use of gas water heaters.

4.3.3. Electricity

Due to the lack of consistency in the on-file records for this utility, the researcher was only able to analyze and track power usage trends for seven consecutive billing periods for each year that the current facility has housed the women's shelter. Consequently, the researcher evaluated the utility records for the billing periods ranging from February - March to August – September for the years 2013, 2014 and 2015. The lowest power usage during this time period was documented in the billing cycle from April - May in 2013 with an average daily kWh usage of 199 kWh. The highest power usage was documented in the billing cycle of July to August in 2015 with an average daily kWh usage of 1084 kWh. The year 2015 on average has proven to have the most power usage with an average daily kWh usage of 20,846 kWh as compared to 20,526 kWh in 2014 and 14,503 kWh in 2013.

4.3.4. Combined utility analysis

Because of the sporadic availability of the archival utility records for gas, water and power, the researcher requested an overall financial listing of utility costs for the shelter from the time the site was purchased by the shelter. In the year that the facility was purchased, the shelter spent approximately $47, 989.94 on utilities. In 2014, the utilities amounted to approximately $50,337.49 and in 2015 (from January until November) the total utility costs amounted to approximately $45,302.59. Based on these records, the average monthly utility cost for the women's shelter is approximately $3,340.23 with the utility cost per square foot averaging $0.21/sf. Overall, it is difficult to use the financial information from 2013 due to the fact that the shelter was purchased in this year and was not used to its full capacity until later into the year. Nonetheless, if the shelter continues the utility increase

trend of 7.4% that was shown from 2014 to 2015, monthly expenses will amount to an average of approximately $4,865.50 in 2016. When looking at the seven-month snapshot from February to August, power usage at the women's shelter seemed to trend upward. Overall, the financial expenditure evaluation revealed the same trend in power usage.

4.4. *Staff Interviews*

The women's shelter had five women on staff at the time of the interview recordings. Interviews revealed that the average staff member had been employed with the shelter four months and only 1 out of 5 of the staff members were present when the building was inherited. According to her account, when the building was purchased "the building was left completely full of everything that Mental Health didn't want." In addition to housing the left-overs from the previous tenant, the building "had been vandalized and a lot of the heating and air units had been stolen. Most of the plumbing didn't work. The whole building needed to be painted. Everything had to be cleaned. There was no stove, no fryer, no refrigerators, no anything like that to keep food in. No blinds on the windows, a lot of the windows were broken out. It had been an empty vacated building."

Even with the complaints about the facility, overall, staff members were somewhat satisfied with the facility when it comes to maintenance requirements, monthly costs, etc. Three out of the five staff members were neutral in their level of satisfaction with the facility. One Staff member stated that she was somewhat satisfied, while the last staff member stated that she was very satisfied. However, the main reasoning behind the more satisfied staff members' responses revolved around merely being thankful to have a facility whereas the neutrally satisfied staff members mainly expressed that their neutrality could be attributed to the many maintenance and repair issues that the facility presents. The interviews also revealed that generally, staff members are not aware of the more specific requirements of the building, but they are generally well aware of the state of the facility and the more general requirements.

During one of the staff interviews, a staff member expressed her concern with the fact that they shared the same neighborhood with the "drug dealers and prostitutes" of which many of the residents were formerly associated. In light of these kinds of security issues and social failures, the women's shelter failed to fully thrive socially. Unfortunately, the shelter was not thriving either economically or environmentally. Over all, staff members feel as though residents are generally satisfied with the facility and most complaints from both staff members and residents would mainly include concern for: temperature regulation, accessibility, plumbing issues and the leaking roof.

4.5. *Resident Questionnaire*

A resident survey questionnaire was given to residents and administered in a group setting. Each question was formulated to gain insight into: resident perceptions of women's shelter's current facility, resident time spent at the shelter and some of the habits that residents implement while using the facility. The average resident at the women's shelter was between 44-48 years old with the most residents falling in the 54-58 years old category. The majority of the residents at the women's shelter had only been a resident for three months or less. According to survey responses, the average resident lived at the shelter for 3-5 months. Residents ranked the facility from 1 to 5 with one being very poor and 5 being very good. The survey responses revealed an average resident satisfaction rating of 4.2.

5. Conclusion

This case of adaptive reuse suggests that the key areas of concern for this facility should be: roofing, plumbing, HVAC equipment, community environment, end-user involvement, insulation, and the condition of exterior windows and doors. The building could better utilize the current layout as well as provide education to residents concerning utility cost savings by limiting use of fans and turning off unnecessary lighting. This facility did not serve as an optimal sustainable solution for the program. Because of the lack of efficiency, the shelter suffered financially with vast increases in gas during the cooler months and significant utilization of electric energy during hotter months. Until major changes are implemented, the shelter leadership will continue to sink unnecessary money into building repairs that do not directly aid in the long-term needs of the shelter.

References

[1] Boehl, -Jessica. (2014, June 5). Future-Proofing Your Building: Designing for Flexibility and Adaptive Reuse –

[2] Bullen, P. A. (2007). Adaptive reuse and sustainability of commercial buildings. *Facilities*, 25(1/2), 20-31. doi:10.1108/02632770710716911

[3] Bullen, P. A., & Love, P. E. D. (2010). The rhetoric of adaptive reuse or reality of demolition: Views from the field. *Cities*, *27*(4), 215–224. doi:10.1016/j.cities.2009.12.005

[4] Cantacuzino, S (1989) Re-Architecture: Old Buildings/New Uses. Abbeville Press, New York.

[5] Davenport, G. (2012, January 12). Embracing Adaptive Reuse. Retrieved from http://www.di.net/articles/embracing_adaptive_reuse/

[6] Douglas, J. (2006). Building adaptation (2nd ed.). Butterworth-Heinemann.

[7] Ellison, L, Sayce, S and Smith, J (2007) Socially responsible property investment: quantifying the relationship between sustainability and investment property worth. Journal of Property Research 24(3), 191–219.

[8] Holyoake, K. and Watt, D. (2002), "The sustainable re-use of historic urban industrial buildings: interim results and discussion", COBRA 2002, available at: www.rics-foundation.org/ index.html

[9] Latham, D. (2000), Creative Re-Use of Buildings, Donhead Publishing Ltd, Shaftesbury.

[10] Spector, S (2003) Creating schools and Strengthening Communities through Adaptive Reuse. National Clearinghouse for Educational Facilities, Washington.

[11] Thomsen, A and van der Flier, K (2006) XXXIV IAHS, World Congress on Housing, Sustainable Housing Design, September 20–23, 2006: Life Cycle of Dwellings; a Conceptual Model Based on Dutch Practice. IAHS, Naples.

[12] Yung, E. H. K., & Chan, E. H. W. (2012). Implementation challenges to the adaptive reuse of heritage buildings: Towards the goals of sustainable, low carbon cities. *Habitat Internation*, 36(3), 352-361.