

Rehabilitation as a Strategy to Increase the Sustainability of the Built Environment

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Abstract: As the costs of new construction skyrocket, more and more attention is being paid to rehabilitation of existing structures as a cost-effective and otherwise attractive strategy for meeting human needs for built facilities. Rehabilitation is a catch-all term which encompasses many meanings, but in the context of this paper we take it to mean the strengthening, changing, or improvement of existing facilities such that those facilities meet current performance requirements necessary for their intended use. We show that rehabilitation of existing structures should be a central strategy for creating a sustainable environment that meets human needs while maintaining the natural environment in a healthy and useful state.

Sustainability With Respect to Built Facilities

In the creation or rehabilitation of built facilities, there are many opportunities to improve how design and construction are currently done to make them more sustainable. In addition to the traditional criteria of cost, time, and quality, three general objectives should shape the implementation of sustainable design and construction. These objectives are:

- Accommodating human needs and aspirations
- Avoiding negative environmental impacts
- Minimizing consumption of matter and energy

In the following subsections, we consider each of these three objectives of sustainability with respect to built facilities, and show how they relate to the overall objective of achieving global sustainability by improving the fabric of the built environment.

Accommodating Human Needs and Aspirations

The first objective of sustainable construction is accommodating human needs and aspirations. This objective has always, either directly or indirectly, been the fundamental reason to undertake construction projects. Buildings meet our basic needs for shelter, warmth, and security, and serve as shells for the activities which meet our needs for food, water, and social contacts. The built environment serves as the foundation for nearly all human activity, and as such is an essential component for the task of accommodating human needs and aspirations. Economic activities are sheltered by the built environment, and a significant component of economic activity in both developed and undeveloped countries is the building construction industry. Thus, the built environment is inextricably tied to sustainability since it is essential for accommodating human needs.

Avoiding Negative Environmental Impacts

Second, causing minimal negative environmental impacts (as well as maximizing positive impacts) is an important objective of sustainability since the environment consists of ecosystems whose ongoing health is essential for human survival on Earth (Goodland 1992). Sustainability of the human race requires that ecosystems be protected and preserved in a reasonable state of health by maintaining biodiversity, adequate habitat, and continued generation of natural resources by the environment.

Built facilities impact the natural environment in many ways. Given their large scope and long life cycles, built facilities have particularly significant and long-lasting effects on the environment as a whole. Ensuring that built facilities avoid negative environmental impacts over their life cycle is an

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essential objective for ensuring that the natural and human environments remain healthy, and thus is an important objective for achieving sustainability.

Minimizing Consumption of Matter and Energy

The third objective of sustainability with respect to the built environment is minimizing the consumption of matter and energy. By subjecting materials and energy to consumption processes in our human activities, we decrease their potential utility to current and future generations. We also impact the natural environment by taking materials and energy from to be used in facility construction, since the environment is the ultimate source of all resources used for creating those facilities. Therefore, consuming as little matter and energy as possible, or “doing more with less,” is a fundamental objective of sustainability.

How can Rehabilitation Contribute to Sustainability?

Given the three basic objectives of sustainability with respect to built facilities, along with the traditional considerations of cost, time, and quality, how can rehabilitation of existing structures help to work toward a state of sustainability for human built systems? In the following subsections, the contributions of rehabilitation as a strategy for meeting human needs within the built environment are presented as they relate to sustainability.

Minimizing Consumption of Matter and Energy

Minimizing the consumption of matter and energy over the life-cycle of built facilities is one of the primary advantages of rehabilitation. By extending the useful service life of buildings or infrastructure, rehabilitation avoids most of the consumption of matter and energy associated with construction of new facilities. Whether by repairing damaged facilities or renovating them to serve new purposes, rehabilitating existing structures is a practice which contributes to sustainability by reusing existing materials and avoiding much of the energy consumption used for new construction.

Reusing Existing Materials

By reusing most of the materials which already exist in a facility, rehabilitation prevents the consumption of huge amounts of matter and energy which would otherwise be required to process, transport, and install new materials in a replacement facility. Since the expenditures of matter and energy which have already occurred to build the facility cannot be undone, the most sustainable alternative in creating a facility to meet human needs is generally to rehabilitate an existing facility. Building materials in general have a relatively large embodied energy, defined as the total energy expended for harvesting, transporting, processing, packaging, and installing the material. Compared to creating a new facility “from scratch” or even recycling materials from one demolished facility into a new one, rehabilitation avoids much of the energy expenditure and material waste which generally occurs in constructing new facilities.

Avoiding Additional Energy Consumption

As noted in the previous section, huge amounts of energy consumption are associated with constructing built facilities: as embodied energy in the component materials, by the equipment used to construct the facility, as well as in the operation and maintenance of the facility. When rehabilitation of an existing structure is selected instead of new construction, much of this energy consumption is avoided. By reusing existing materials and avoiding the energy expenditure associated with demolition and new construction, rehabilitation is a sustainable strategy because it reduces the overall consumption of matter and energy within human built systems.

On occasion, however, the energy efficiency properties of existing structures are inferior to new materials. For example, new thermal window assemblies usually surpass by far the thermal energy efficiency of the single-pane windows often found in existing structures. In cases like this, rehabilitation of the facility should include removal of the old, inefficient fixtures and replacement with newer, more efficient ones to avoid larger energy consumption during operation of the facility. Life cycle energy analysis is one technique which can be used to assess the tradeoffs associated with replacement of building fixtures (DOE 1992).

Avoiding Negative Environmental Impacts

Avoiding negative environmental impacts, along with encouraging positive impacts, is a second major objective of sustainability with respect to built facilities. Negative impacts of built facilities range from displacement of natural ecosystems on building sites, to over-harvesting of natural resources from ecosystems, to generating vast amounts of waste as a result of constructing, operating, and demolishing facilities. By reusing existing sites and reducing the amount of waste generated as a result of the facility life cycle, rehabilitation contributes to sustainability by helping to avoid negative environmental impacts.

Reusing Existing Sites

One of the most fundamental ways in which rehabilitation avoids negative environmental impacts and promotes positive environmental action is by reusing existing buildings and the sites on which they stand. The sites of such facilities have *already* been impacted by human changes, and making further changes to the site is not likely to impact the natural environment as much as building a new facility at a greenfield site. Reusing an existing site avoids much of the destruction of natural habitat, soil erosion, and generation of fugitive emissions such as runoff, noise, and dust which typically impact the natural environment in greenfield construction. In addition, many rehabilitation projects include plans for environmental rehabilitation of the surrounding site and landscaping, creating the potential for positive environmental impacts as a result of the project (Heintz & Wosser 1994).

Reducing Construction and Demolition Waste

Along with the other benefits of reusing existing materials, rehabilitation has the added benefit of reducing the amounts of material waste typically generated by new construction. As much as 10% of the waste received by municipal solid waste landfills is generated by construction and demolition of built facilities (von Stein 1993). By rehabilitating existing structures, this waste generation is largely avoided. Materials *already used* to build the facility are kept as part of the structure, rather than reduced to demolition waste if the structure were demolished and replaced. The quantity of new materials added to the rehabilitated structure is much smaller than that which would be necessary to build a replacement structure, and thus the amount of residual waste such as packaging that is associated with installing these new materials is much smaller. By reducing the amount of waste from construction projects, rehabilitation of existing structures contributes significantly to the sustainability of the built environment.

Accommodating Human Needs and Aspirations

The third objective of sustainability for the built environment is accommodating human needs and aspirations. Rehabilitation of existing structures contributes to this objective in various ways, including meeting new performance requirements for existing facilities, preserving the architectural history of older facilities, and contributing to the revival of urban areas.

Meeting Performance Requirements

One of the most basic reasons for engaging in a rehabilitation project is to bring older facilities up to current performance requirements, either due to new codes to which the facility must adhere, or to adapt the structure for new intended uses which have different performance requirements. By rehabilitating a structure to meet new performance requirements, we enable the structure to meet the human needs or aspirations which created those requirements. Thus, rehabilitation enables human needs to be met without the necessity of creating new facilities.

Preserving Architectural History

Preserving architectural history is important because older facilities subject to rehabilitation often contain valuable architectural assets which are not present in newer facilities. Old buildings were often constructed with goals other than economic and structural optimization in mind, and thus have valuable architectural attributes which would never be built in replacement facilities due to economic constraints. Such features include cohesion with the surrounding architectural fabric of the community, solidity of construction which imparts feelings of solidness and security to users, and historically important details such as stone carvings, wrought iron ornamentation, and stained glass windows, which make the facility aesthetically attractive.

By preserving these qualities and attributes in rehabilitation, the often infeasible cost of replicating them in new facilities is avoided. In newer construction where cost is often the overriding decision criteria, such features are either replicated as facades using inferior materials, or omitted altogether. Such replication reduces the *authenticity* of the structure, rendering it of intrinsically lesser value than the original structure which might have been rehabilitated. Careful planning of rehabilitation projects often enables these attributes to be preserved at far lower costs than replacement, and preserves the facility within the architectural fabric of the community in which it exists.

Reviving Urban Areas

Urban blight is often a problem in major cities, particularly in the areas where facilities with potential for rehabilitation are sited. When rehabilitation of those facilities is selected as an alternative to replacement at a different site, the surrounding community benefits from the renewal of the facility. Not only is the site of the facility itself rehabilitated and increased in beauty, but also the project can serve as an impetus to encourage further rehabilitation in the area. Bringing commercial or residential activity to an old neighborhood stimulates the economy of the area, which may cause future economic activity to flourish. Spin-off effects from urban rehabilitation include reduced new development in suburban areas with all the associated negative environmental impacts, and a reduction in transportation requirements for users of the new facilities due to proximity to urban amenities. All these benefits are evidence that rehabilitation can contribute to sustainability by helping to meet human needs and aspirations.

Cost, Time, and Quality

Cost, time and quality are the traditional criteria of design and construction, and have guided project decision making more strongly over the past century than ever before. In the following subsections, we discuss how rehabilitation surpasses new construction in terms of sustainability by creating economic advantages for owners and communities, saving time needed for new construction, and maintaining traditional quality standards.

Creating Economic Advantage

In addition to the economic benefits of urban renewal, rehabilitation of existing facilities often provides an economic advantage to owners of these facilities. Rehabilitation projects often cost far less than new, replacement construction due to their reuse of existing material and energy components. Rehabilitation of existing facilities eliminates the need for much of the sitework needed for greenfield construction, and thus saves money for prospective developers. Finally, rehabilitated projects are often more attractive to prospective tenants, due to their historical qualities, proximity to urban amenities, and unique architectural attributes (Heintz & Wosser 1994).

Saving Time Needed for New Construction

Rehabilitating old facilities often saves significant amounts of time compared to that required for replacement construction. Due to the reuse of part or all of the existing structure and sitework, time requirements are often significantly reduced to bring the facility up to meet performance standards. Sometimes, however, rehabilitation adds to the design and construction time needed to finish the project. Unfamiliarity with older materials, the necessity of detailed structural evaluation and planning, or the need to work around users of the facilities are potential pitfalls of rehabilitation projects which can add to the overall time needed to complete the project. In many cases, however, the net benefits resulting from choosing rehabilitation over new construction offset any additional time requirements.

Maintaining Traditional Quality Standards

The quality standards used in traditional construction often surpass the standards dictated today by economic optimization. Particularly with older structures, the component materials are often of a higher quality that is not even available on the current market. By rehabilitating these older, higher quality structures instead of building replacements according to current standards, we can take advantage of the lower labor and material costs and higher quality standards enjoyed by our ancestors, rather than throwing their work into a landfill.

Conclusions

In conclusion, we have shown throughout this paper that rehabilitation of existing structures is nearly always superior to new or replacement construction in terms of the various aspects of sustainability and sustainable development. Rehabilitated projects provide many advantages, including maintenance of historical and architectural integrity, revitalizing urban areas, and avoiding negative environmental impacts and unnecessary consumption of materials and energy. In planning a sustainable rehabilitation project, it is necessary to consider the surrounding context of the project, potential impacts to the human and natural environment, and economic viability compared to other alternatives. Sustainability as a decision criterion encompasses all of these considerations, and can serve as a governing objective for all project decision making which will help to ensure the survival of the earth and its inhabitants into the foreseeable future.

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