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ECONOMICALLY CONTROLLED RECONSTRUCTION: A METHODOLOGY OF PHASED REPAIR WITH SAFETY- AND BUDGET-BASED PRIORITIZATION

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ABSTRACT

The physical wear of the residential and industrial building stock consistently outpaces the funding available for its restoration, and this gap has to be managed across the whole service life of a facility rather than resolved in a single campaign of works. This article proposes a methodology of economically controlled reconstruction that orders repair works by two measurable criteria: safety and budget. The study reviews the theoretical foundations of phased repair and the problem of assessing the economic effect of restoration investments, then describes a procedure for diagnosing the technical condition of structures and for constructing a safety index that aggregates the technical-condition category, the percentage of physical wear, and the type of structure. On this basis a priority matrix is developed, linking the safety rank of a defect to the ratio of its expected effect to its cost, and a four-stage model for allocating a limited budget is derived from the matrix. The resulting schedule places threats to life and stability first, follows them with quickly paying energy and engineering measures, and defers comfort-related works. The approach applies to the planning of major repairs in both residential and industrial building stock and allows the schedule to be reassembled when funding changes, making it an instrument of long-term condition management rather than of a one-off estimate.

Keywords: Building reconstruction; Phased repair; Prioritization of works; Structural safety; Life-cycle cost; Capital repair budgeting

1 INTRODUCTION

A substantial part of the residential and industrial building stock has been in service for decades, and the physical wear of load-bearing and enclosing structures is gradually approaching its limit values. At the same time, the resources that owners and public programs can direct toward restoration are limited. A gap emerges: the volume of necessary work noticeably exceeds the available funding. This gap has to be managed not as a one-off event but throughout the entire service life of the building.

Practice shows that an attempt to carry out the whole set of works at once most often runs into a shortage of funds and leads to stalled projects. A more robust logic is different: to break restoration into stages and arrange them so that every unit of money spent first closes threats to life and stability, and only afterward improves comfort and operating economics. Such an approach requires transparent rules by which some works are recognized as first-priority while others are postponed.

The aim of this work is to propose a methodology of economically controlled reconstruction in which the phasing of repair rests on two measurable criteria: safety and budget. Economically controlled reconstruction is understood here as a managed process of restoring a facility in which each stage of work is justified by the technical-condition category of the structures and by an assessment of costs relative to the resulting effect. The objectives of the article include describing the theoretical foundations of the approach, the diagnostic procedure, and the construction of a priority model for allocating limited funds.

2 THEORETICAL FOUNDATIONS OF ECONOMICALLY CONTROLLED RECONSTRUCTION

A distinction among concepts frames the whole methodology. Routine repair maintains the serviceability of individual elements, capital repair restores the resource of structures and engineering systems, and reconstruction changes the parameters of the facility, such as floor area, number of storeys, or function. Economically controlled reconstruction unites these levels into a single queue of works subordinated to a common goal: to extend safe operation within a fixed financial ceiling. What becomes decisive is not the type of work in itself but its place in the priority queue.

Building maintenance decisions rest on complex and often conflicting criteria, which is why they are best framed as multi-criteria decision-making problems rather than single-cost calculations [1]. This view shifts the evaluation away from a single financial figure toward a set of ranked considerations. For a phased-repair methodology this matters: priority is assigned not to what yields income but to what a structured comparison of criteria places highest. The criterion set, not the invoice alone, drives the order of works.

The indicators that shape the maintenance-and-repair system of residential buildings can be weighted and ranked, and a combined multi-criteria procedure allows the most appropriate policy to be identified from them; in such a ranking, safety and health criteria come out highest [2]. It follows that no universal schedule of works exists; the queue is formed for the structure and wear of a specific array of facilities. Planning proceeds from the actual condition rather than from averaged norms. The ranking of indicators, not habit, decides what comes first.

Cost management begins long before work reaches the site. A cost-optimal, life-cycle-cost approach can determine in advance which package of renovation measures leads to the lowest life-cycle cost over the economic life of the building [3]. An early cost estimate reduces the risk that the queue of works will prove financially unfeasible. The sooner the budget ceiling is fixed, the more precisely the sequence of stages can be built.

The upshot of the theoretical part is straightforward. Reconstruction is treated as a process extended in time and managed by life-cycle cost. Economic control means that at each step the cost of a stage is weighed against its contribution to safety and operating economy. This distinguishes the methodology from a one-year estimate. Manageability appears: the queue can be reassembled when funding changes without losing the logic of priorities.

3 DIAGNOSTICS AND SAFETY-BASED PRIORITIZATION

Any queue rests on diagnostics. A condition assessment establishes the degree of damage and the technical-condition category of structures by comparing observed indicators with design and normative values. Without this procedure, prioritization turns into guesswork. Diagnostics translate subjective concern into measurable categories.

The categories of technical condition form a natural scale of urgency. Normative and operable states allow planned use; a limited-operability state calls for monitoring and remedial measures; an emergency, unsafe state prohibits normal use until the threat is removed. This scale becomes the first filter of the queue: the closer a structure is to the emergency category, the higher its place in the schedule. Safety-based priority is, above all, a movement from emergency elements toward operable ones.

Physical wear supplements the categorical assessment with a quantitative measure, evaluated element by element rather than by the building's overall age. Because the foundation, roof, façade, and engineering networks wear unevenly, a whole-building age says little about the urgency of specific works. Criteria bearing on the health and safety of occupants warrant individual consideration with higher priority, regardless of cost and funding availability [1]. Here the economic criterion temporarily yields: a threat to life is not postponed to save money.

Safety priority demands particular attention to the structural skeleton. The failure of a load-bearing member threatens life and collapse, whereas worn finishes affect only comfort, so the weight of these defects in the queue is not comparable. Life-cycle frameworks make this explicit by treating the average annual loss of life, alongside cost, as a decision variable for selecting a retrofit strategy [4]. Works that reduce the risk of collapse, fire, or the failure of life-support systems receive the highest rank irrespective of their cost.

The practical output of this section is a safety index for the facility. It aggregates the condition category, the percentage of wear, and the type of structure (load-bearing, enclosing, or finishing) into a single value that ranks all identified defects. The higher the index, the earlier the work enters the schedule. Such an index makes the first, protective contour of prioritization transparent and reproducible.

4 BUDGET-BASED PRIORITIZATION AND THE PHASED-REPAIR METHODOLOGY

The second contour of prioritization introduces the budget. Once the safety index has ranked the defects, each work is assigned an estimate of cost and of expected effect: averted damage, operating savings, or gains in residual value. Prioritizing the maintenance of the most critical services allows the maintenance cost to be optimized rather than simply minimized item by item [5]. Comparison proceeds not by absolute price but by the ratio of effect to cost, so a cheap work with a high protective effect outranks an expensive one with modest returns.

Energy-saving measures are a characteristic example of works with a measurable economic return. Breakeven analysis based on net present value and payback period shows how the long-term savings from a retrofit, not merely its one-off cost, determine whether it is worthwhile [4]. In the queue such measures sit immediately behind safety works, since they return part of the investment through lower operating payments. Saved resources act as an internal source of funding for later stages.

A priority matrix links the two contours. One axis carries the safety rank; the other, the ratio of effect to cost; their intersection sets the queue position of a given work. The upper corner of the matrix, holding cheap works that are critical to safety, is executed first, while the lower corner, holding expensive and non-critical works, is deferred to later stages or dropped when funds are short. The matrix turns a scattered list of defects into a manageable schedule.

On the basis of the matrix, a staged model is built. Stage zero is inspection and cost estimation, without which the queue is unreliable. Stage one closes emergency and limited-operability load-bearing structures together with fire-safety and life-support systems. Stage two covers engineering networks and quickly paying energy measures. Stage three addresses enclosing structures and site improvement that affect comfort and value. Scheduling stages so as to minimize total maintenance cost is precisely how the recurring problem of deferred maintenance in aging building stock is contained [6].

Feedback and a reserve give the model its stability. After each stage the diagnostics are repeated and the matrix is reassembled to reflect the new condition and actual prices. A reserve within a reasonable share of the budget covers hidden defects revealed when structures are opened up. This cycle of assess, work, and reassess is what makes the reconstruction economically controlled throughout, and not merely at the moment the first estimate is drawn up.

5 CONCLUSION

The proposed methodology describes reconstruction as a cost-managed process in which the queue of works is formed by two measurable criteria. The first contour, safety, ranks defects through the technical-condition category, the percentage of wear, and the type of structure, bringing threats to life and stability to the front. The second contour, budget, orders the remaining works by the ratio of effect to cost. The priority matrix and the staged model tie these contours into a single schedule funded stage by stage.

The practical value of the approach is that it turns a shortage of funds from a dead end into a condition of planning. A limited budget does not cancel restoration; it sets its sequence, in which threats are removed first, investments are then recovered through operating savings, and only afterward are questions of comfort resolved. The methodology applies to both residential and industrial stock and allows the schedule to be reassembled when funding changes. It becomes an instrument not of a one-off estimate but of the long-term management of a facility's condition.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The author declares that there is no conflict of interest regarding the publication of this article.

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