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# Resource Optimization For Waste Reduction On Construction Projects

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***Abstract:*** A large amount of material, labour, equipment and energy is lost as waste throughout the life cycle of construction projects. Material waste can reach double-digit percentages for key products such as concrete, masonry units, timber and finishing materials, while process waste can cause unnecessary labour, waiting time and avoidable transportation. These inefficiencies drive cost overruns, schedule delays and environmental impacts, yet they are often treated as side effects rather than symptoms of sub-optimal resource management. Resource optimisation and waste reduction can be addressed through a unified management framework. This paper builds on concepts from lean construction, highlighting lean production control and digital tools as key enablers.

To make these concepts actionable for practitioners, the paper introduces stage-wise tables of strategies, a conceptual figure linking resource decisions to waste streams, and key performance indicators for monitoring materials, labour, equipment and schedule performance. Implementation challenges related to organisational fragmentation, information gaps, capacity constraints and technology integration are discussed, and recommendations are provided for embedding resource optimisation into everyday project practice.

***Index Terms* -** Construction waste, resource optimization, lean construction, waste minimization, materials management, just-in-time delivery, site logistics planning, building information modelling (BIM), resource-constrained scheduling, performance indicators.

## I. Introduction

Construction projects are inherently resource intensive. Multi-trade crews use a variety of equipment to assemble large volumes of cement, aggregates, steel, timber and manufactured components. Construction takes place in temporary, open environments with varying weather conditions and site constraints. There are many opportunities for miscoordination. When designs are altered during construction, when deliveries arrive earlier or later than required, or when trades are not properly planned, resources are consumed without producing corresponding economic value. This results in piles of discarded material, incomplete work that must be demolished and redone, and equipment that is standing idle. The first step in the optimisation process is recognising and quantifying losses. In different countries, reported material waste percentages vary. According to measurements from real projects, concrete waste can reach 10–15% of delivered quantity, while masonry or finishing waste can be similarly high [2]. These percentages represent a significant portion of the project budget. In addition, labour-related waste in the form of waiting, rework, unnecessary movements and unproductive meetings erodes productivity and complicates schedule control [1].

Traditional responses to waste focus on disposal and recycling. Many organisations only measure waste when it leaves the site and is weighed at a landfill or recycling facility. This perspective treats waste as an unavoidable by-product rather than a signal that upstream processes are not optimal. Lean construction and modern project-management approaches treat waste as any activity that does not add economic value for the customer and seek to eliminate it through better planning and feedback [1]. Resource optimisation is more than just cutting costs; it is about designing and operating production systems that convert inputs into outputs efficiently and predictably. The central proposition of this paper is that there is a clear pathway for waste reduction on construction projects. Project teams can identify structural causes of waste by examining how resources are specified, procured, scheduled, moved and transformed. The remainder of the paper outlines how this can be accomplished.

## II. CONSTRUCTION WASTE AND RESOURCE FLOWS

### A. Types and Sources of Waste

Construction waste reflects the different ways in which resources fail to contribute to the finished product. Material waste occurs when delivered materials are damaged, cut into unusable off-cuts, left unused due to design changes or stored in ways that lead to deterioration. Formoso et al. show that even on projects considered well managed, significant portions of materials such as blocks, ceramic tiles, timber and concrete never become part of the finished building [2]. This waste is often visible in skips and stockpiles, but its root causes may lie in design decisions, procurement procedures and site logistics.

Process waste includes rework, waiting, unnecessary transport and excessive movement. Lean construction models emphasize that activities such as repeatedly moving materials around the site, queuing trades due to poor sequencing, or conducting inspections that do not lead to learning are all forms of waste [1]. The visible heaps of off-cuts are only one symptom; extra labour hours, equipment use and longer project durations are also consequences of process waste. In many projects, process waste may account for a larger share of inefficiency than material waste.

A third category is time- and space-related waste, which arises when overcrowding, cluttered work areas and poor site layout lead to double handling and reduced productivity. When materials are stored far from their point of use, workers spend more time walking. Work must be stopped or slowed when access routes are blocked. Over time, these seemingly minor inefficiencies accumulate into substantial delays and increased labour and equipment costs [4]. A proper understanding of construction waste therefore requires a perspective that connects physical materials with the processes and environments in which they are handled.

**Table 1: Classification of Resource-Related Wastes on Construction Projects**

| Resource category | Waste type | Typical causes | Example indicators |
|---|---|---|---|
| Materials | Off-cuts, breakage, leftovers, obsolete inventory | Over-ordering, design changes, poor storage, inaccurate drawings or quantity take-off, rough handling | Material waste index (% of delivered quantity), cost of discarded material |
| Labour | Idle time, rework, unnecessary motion | Poor planning and sequencing, unclear drawings, missing information, lack of tools and equipment, frequent changes | Labour productivity (output per labour-hour), rework man-hours, share of rework hours (%) |
| Equipment | Idle plant, under-utilised tools and machinery | Unbalanced schedules, breakdowns, lack of trained operators, poor coordination between trades and equipment availability | Equipment utilisation rate, standby costs as percentage of total equipment cost |
| Space | Congestion, double handling, blocked access | Inadequate site layout, cluttered storage, poor housekeeping, shared access routes, absence of designated storage zones | Number of material moves, time spent searching/relocating materials, near-misses |
| Time | Waiting, schedule float lost due to disruptions | Late deliveries, clashes between trades, slow inspections, design changes, poor information flow | Percent Plan Complete (PPC), schedule variance, total delay days |

Source: adapted from [1], [2], [4], [13], [14]. Resource categories are linked to specific forms of waste. Poor planning, inaccurate information, and inadequate supervision are some of the root causes.

**B. Relationship Between Resource Inefficiency and Waste**

Waste is ultimately a manifestation of resource inefficiency. Whenever the quantity, timing or quality of resources supplied to a project deviate from what is actually needed, the gap becomes waste. Over-ordering of materials leads to surplus inventory at the end of the project, while under-ordering causes stoppages and emergency procurement that can result in poor handling and additional off-cuts. Overloaded schedules with more activities than can be supported lead to overcrowding and rework, which in turn generate waste [4]. Resource planning and control are directly related to waste outcomes. Inaccurate quantity take-off, design changes during construction and inadequate storage are some of the major contributors to material waste [4]. Components may not fit as they should when drawings are not coordinated. Extra labour spent on rework cannot be recovered. Projects that achieved lower levels of material waste typically had clear supplier selection, framework agreements and detailed bills of quantities in place [8].

Similar patterns appear on the scheduling and labour side. When resources are balanced and activities are sequenced to avoid peaks and troughs, labour and equipment time can be reduced [9]. Crews often arrive on site and find that work fronts are incomplete because of unbalanced schedules. They then engage in partial work, temporary fixes or rework, all of which create waste. When waste is viewed through the lens of resource flows, waste reduction becomes inseparable from better planning, coordination and control of resources.

## III. THEORETICAL BACKGROUND: LEAN CONSTRUCTION AND DESIGN FOR WASTE MINIMISATION

### A. Lean Construction Perspective

Lean construction adapts ideas from lean production to the specific context of projects. Koskela argued that construction should be seen as a combination of transformation, flow and value generation [1]. Improving the efficiency of individual activities may not improve overall project performance if flows between activities remain unstable. Lean construction aims to improve reliability, reduce variability and promote continuous improvement.

Overproduction, waiting, unnecessary transport, over-processing, excess inventory, unnecessary movement and defects are some of the process wastes identified in the lean perspective [13]. Each form of waste can be mapped to resource use. Overproduction consumes materials and labour before they are needed. Waiting ties up labour and equipment without generating value. Excess inventory increases the risk of damage and obsolescence. Defects require rework, consuming additional resources while discarding earlier work. Project teams move towards more efficient use of resources when they systematically identify and reduce these wastes. The Last Planner System is a collaborative planning and control approach in which trade foremen and supervisors make short-term commitments based on what can actually be achieved [13]. Tracking plan reliability through a metric such as Percent Plan Complete helps teams identify recurring causes of non-completion, such as missing materials or design information. This reduces the need for emergency measures that generate waste. Learning and engagement are reinforced by visual management tools.

### B. Design-Stage Strategies

Design decisions lock in many aspects of resource use before construction begins, making waste-minimisation opportunities greatest at the design stage. Design guidelines for waste minimisation have been proposed [3]. When room dimensions are aligned with standard plank or panel sizes, fewer cuts are required on site and off-cut lengths can be reused in other locations. Rationalising structural grids reduces formwork waste and allows more efficient use of reinforcement.

Design teams can use digital models to simulate material quantities and cutting patterns. Liu et al. used such methods to evaluate waste levels in a virtual environment [5]. By changing the layout of façade panels, designers can influence the number and size of off-cuts. They can explore prefabricated options and adjust detailing to maximise the proportion of components that can be manufactured off-site with high precision. The amount of on-site adjustment is thereby reduced. The influence of organisational and behavioural factors on waste minimisation should not be underestimated. Li et al. found that designers are more likely to consider waste minimisation when decision-support tools are available [6]. Designers have limited incentive to invest in resource-efficient solutions in firms where projects are priced and evaluated solely on the basis of upfront construction cost. Resource optimisation at the design stage is therefore as much a management and cultural task as a technical one.

### C. Procurement, Planning and Control

There is a bridge between design intent and site execution. Waste-efficient procurement models highlight the importance of aligning supplier capabilities and logistics practices with project resource goals. Suppliers' commitment to low-waste packaging, careful handling, effective delivery systems, and accurate bills of quantities were identified as critical factors [8]. When these elements are in place, materials arrive in appropriate quantities, at appropriate times and in formats that minimise cutting and repackaging. Suppliers can also participate in take-back schemes for pallets or packaging.

Design-stage plans are transformed into daily work plans. Activity durations and costs depend on the availability of labour and equipment [9]. Tiwari et al., in the methods reviewed, show that optimisation techniques can reduce peaks in resource requirements while maintaining or even reducing overall project duration [9]. Resource profiles become smoother, leading to more stable and less wasteful site operations. Control systems close the loop by monitoring performance. Lean-based control uses visual methods to track task completion and identify constraints before they disrupt work [13]. When an activity cannot be completed due to missing materials or information, the reason is recorded and analysed so that teams can address systemic issues. In this way, the cycle of planning, execution, measurement and learning becomes continuous.

## IV. INTEGRATED FRAMEWORK FOR RESOURCE OPTIMISATION AND WASTE REDUCTION

### A. Conceptual Framework

Resource-related decisions are directly linked to waste outcomes. The main project stages are design, procurement and planning, and execution. At each stage, decisions are made about materials, labour, equipment, space and time. Material quantities are determined through structural systems and detailing. Managers choose suppliers and negotiate terms. During execution, site managers allocate crews and equipment, while handover teams review performance and capture lessons. Beneath these stages lies a set of resource-decision layers, which interact with the production system shown at the centre of the conceptual figure. The production system is a network of tasks, flows and information exchanges that transform resources into built assets. Resource inputs are matched to task requirements in various ways. When resource decisions are aligned, the production system operates smoothly; when they are misaligned, the system experiences variability.

From the production system, two broad outcome streams emerge. One stream consists of quality and functional performance of the completed asset. The other stream consists of waste outputs. There are opportunities for learning and improvement through feedback loops: measured waste levels can influence future design guidelines and procurement strategies. In this model, Resource Optimisation and Waste Reduction are system-level properties rather than isolated activities.

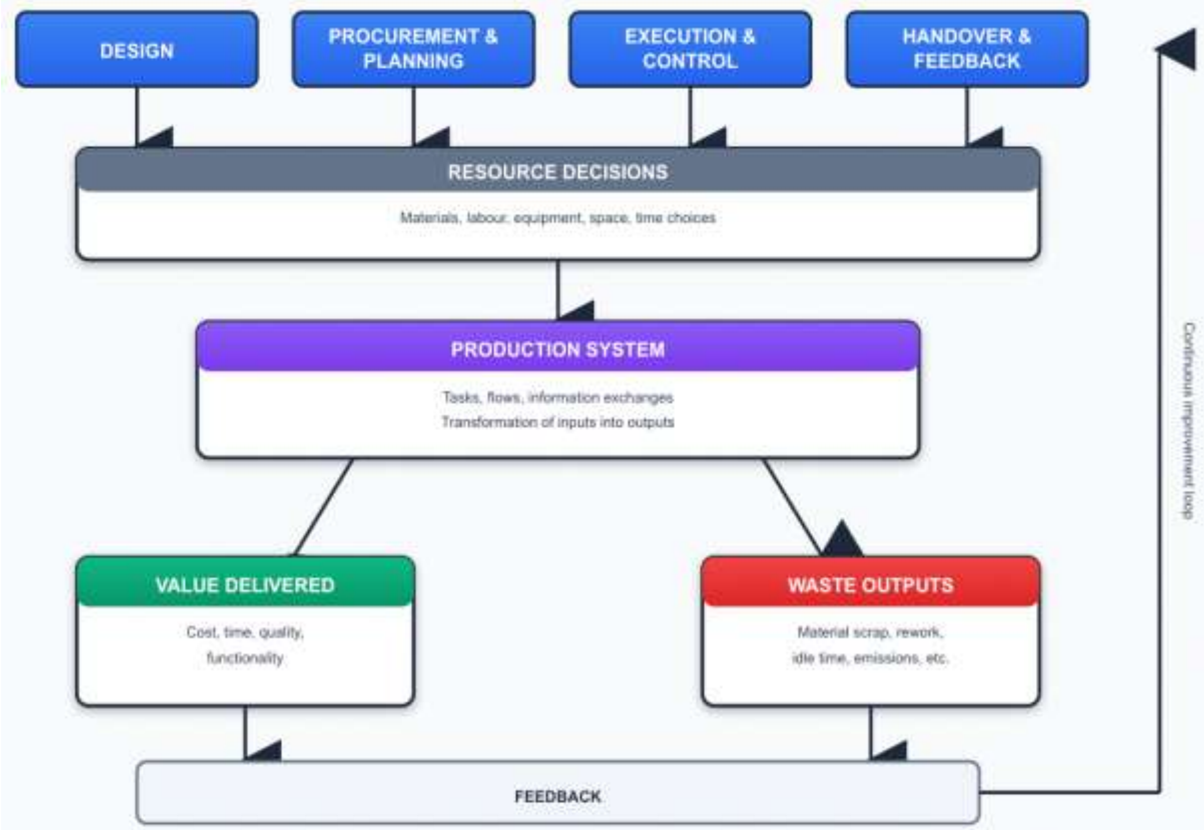


**Figure 1: Conceptual framework linking resource optimisation to waste reduction**

Resource-related decisions affect both economic value and waste outputs, with feedback loops enabling continuous improvement, as shown in Figure 1.

**B. Phase-Wise Strategies**

The conceptual model can be translated into practical strategies at each project stage. Design teams who apply design-for-waste-minimisation principles aim to reduce both material quantities and future rework. They may standardise room dimensions so that drywall, flooring and roofing tile modules can be used efficiently, or design structural grids that align with common formwork sizes. Repetitive modular units can be used in housing or hotel projects to allow off-site prefabrication of bathrooms or service cores, which can be manufactured under controlled conditions with minimal waste [3]. Design choices like these help reduce waste and simplify construction In procurement, contractual clauses that specify acceptable waste rates, encourage suppliers to provide pre-cut materials, and require minimal packaging can support waste-efficient material supply [8]. The procurement team can work with site managers and designers to ensure that orders reflect actual needs. Resource-levelled schedules can then be developed by planning teams, and logistics plans prepared in parallel so that materials are delivered efficiently.

Lean production control mechanisms are critical in the execution and control phase. Before committing to short-term work plans, foremen should identify and remove constraints [13]. When constraints are addressed, weekly work plans become more reliable. 5S housekeeping practices help keep storage areas and workspaces organised, reducing time wasted searching for tools or materials and decreasing the risk of damage. These behaviours can be reinforced through incentives that reward high productivity and low waste. The feedback and handover phase offers an opportunity to institutionalise learning. Post-project reviews can examine which resource-optimisation strategies were effective and which were not. Design libraries and standard details can be updated based on successful practices. By treating each project as a learning laboratory, organisations steadily advance their resource-optimisation model.

**Table 2: Resource Optimisation Strategies and Targeted Waste Reductions**

| Project phase | Strategy group | Examples of measures | Targeted waste types |
|---|---|---|---|
| Design | Design for waste minimisation | Dimensional coordination, modular layouts, repetition of room types, rationalised structural grids [3], [5] | Off-cuts, rework, surplus materials |
| | Design for off-site manufacture | Prefabricated elements, standardised components, pre-cut reinforcement | On-site scrap, labour rework, time waste |
| Procurement & planning | Waste-efficient materials procurement | Supplier take-back schemes, reduced packaging, accurate quantity take-off, pre-assembled products [8], [10] | Packaging waste, surplus inventory, damage during storage |
| | Resource-constrained scheduling | Levelling crew and equipment workloads, just-in-time mobilisation, critical path with resource limits [9]–[11] | Idle labour and equipment, congestion, waiting, rework |
| | Site logistics and layout planning | Dedicated storage zones, clear routes, crane coverage planning, staged delivery | Double handling, damage, motion and transport waste |
| Execution & control | Lean production control | Last Planner System, daily huddles, constraint analysis, visual management [1], [13] | Waiting, defects, rework, variability, incomplete tasks |
| | 5S and housekeeping | Sorting, setting in order, shining, standardising, sustaining | Searching time, motion waste, safety-related disruptions |
| | Skill development and incentives | Training on material handling, bonuses for low waste, worker involvement in improvement initiatives | Improper handling, careless cutting, avoidable rework |
| Handover & feedback | Post-project review | Waste benchmarking, lessons learned, updating design libraries and standard details | Recurring design and planning waste across projects |

Source: synthesised from [1]–[11], [13].

**C. Resource Flow Diagram**

The resource flow diagram focuses on the journey of resources from initial quantity take-off to final disposition. Initial resource requirements are defined in the design and quantity take-off. Downstream processes inherit a flawed baseline if they do not account for waste factors. The procurement and supplier engagement block shows decisions regarding supplier selection and terms. These decisions affect how materials are delivered.

Delivery and site logistics involve transportation, unloading and storage. Damage can be caused by improper handling and inadequate storage. Material and time waste are influenced by decisions such as whether to use covered storage, how to sequence deliveries relative to the schedule, and how to label and locate materials. The on-site transformation phase includes the work of trades supported by equipment. Lean methods, clear work instructions and well-coordinated sequencing are essential to prevent waste. From on-site transformation, the flow splits into productive outputs and waste streams. Performance information from both streams can be fed back into earlier phases in a final feedback block.

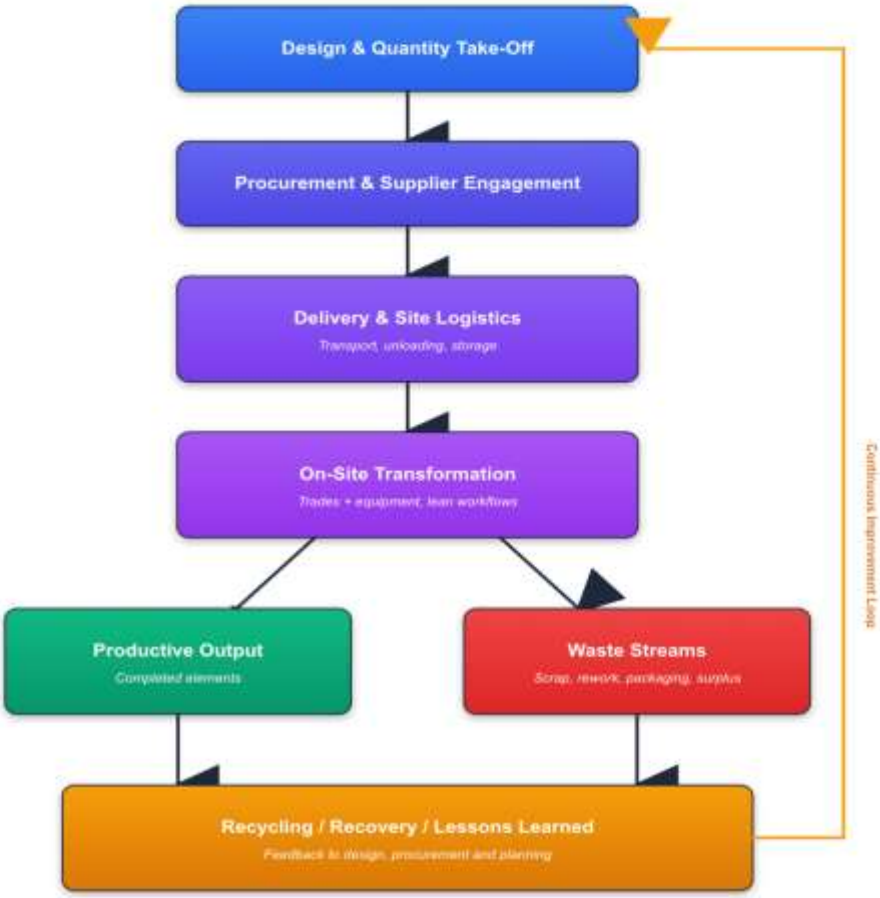


**Figure 2: Resource flow from design quantities to end use**

Flow of resources from design and quantity take-off through procurement, logistics and on-site transformation to productive outputs and waste streams, with feedback for recycling and continuous improvement, is illustrated in Figure 2.

## V. QUANTITATIVE INDICATORS FOR RESOURCE AND WASTE PERFORMANCE

Quantitative indicators are needed to turn broad goals into concrete action. It is difficult to know whether design standardisation is actually improving performance without measurement. The indicators listed in Table III can be used to create a dashboard. The material waste index shows how much material ends up as waste [2]. Contractors need to track both deliveries and waste. Periodic sampling can reveal patterns, such as high waste rates for tiles. The waste cost ratio compares the cost of wasted material with the total material cost. This often reveals a strong business case for waste-reduction measures. Understanding process waste involves labour productivity. Repetitive tasks can be tracked for output per hour. When productivity goes down, project managers can investigate whether the cause is design clashes, poor logistics, or other factors. The rework rate is the proportion of reworked hours to total hours; high rework rates indicate that rework accounts for a large portion of labour time.

The utilisation factor and cost share can be used to identify under-used plant and equipment. A tower crane with low utilisation may indicate that materials are not being scheduled or delivered efficiently, while high costs for specialised equipment may be a sign of poor integration of equipment availability into the schedule. The reliability of weekly work plans is measured by Percent Plan Complete (PPC) [13]. Low PPC suggests that resource constraints or information deficits are preventing tasks from being completed as promised. Waste per unit of floor area is a key waste-performance indicator. Trade-specific waste generation rates show which trades offer the best opportunities for improvement. By regularly reviewing these indicators in a dashboard, resource and waste management can be shifted from occasional initiatives to routine practice.

**Table 3: Key Performance Indicators (KPIs) for Resource Optimisation and Waste Reduction**

| Dimension | Indicator | Definition / formula | Typical data source |
|---|---|---|---|
| Material efficiency | Material Waste Index (MWI) | (Quantity of material waste ÷ Quantity delivered) × 100% | Waste tickets, delivery notes |
| | Waste cost ratio | Cost of wasted materials ÷ Total material cost | Cost reports |
| | Percentage of prefabricated volume | Prefabricated elements volume ÷ Total volume of work | Design/BIM model, procurement records |
| Labour productivity | Output per labour hour | m² of work or concrete volume per labour-hour | Site records, daily reports |
| | Rework rate | Rework labour-hours ÷ Total labour-hours | Non-conformance and rework reports |
| Equipment utilisation | Utilisation factor | Productive equipment hours ÷ Available equipment hours | Plant and equipment logs |
| | Standby cost share | Idle equipment cost ÷ Total equipment cost | Cost and plant charge-out records |
| Schedule reliability | Percent Plan Complete (PPC) | (Number of tasks completed as planned ÷ Tasks planned) × 100% | Weekly planning (Last Planner) records |
| | Schedule variance | Planned duration − Actual duration | Programme vs. progress reports |
| Overall waste | Waste per unit floor area | Total waste mass ÷ Gross floor area | Weighbridge records, as-built drawings |
| | Waste generation rate by trade | Waste mass from trade ÷ Output of trade (e.g., m² installed) | Trade-level measurement and waste segregation logs |

Source: adapted and synthesised from [2], [4], [9]–[11], [13], [14].

## VI. EVIDENCE FROM SELECTED STUDIES

### A. Design and BIM-Enabled Optimization

Design-stage interventions can reduce resource use. Laovisutthichai et al. documented projects where their waste-minimisation guidelines were applied [3]. In some cases, adjusting dimensions by as little as a few centimetres to align with sheet sizes greatly reduced the number of partial pieces required. Designers also found additional benefits when they adopted modular layouts, such as simplified detailing and simpler construction sequencing. Digital models can be used for coordination and visualisation [5]. Information about material dimensions and cutting patterns can be embedded into the model to allow teams to compare alternative designs. Waste analysis encourages earlier collaboration between designers, contractors and suppliers. This collaboration fosters shared understanding of resource constraints and opportunities.

According to research by Li et al. [6], client expectations and support are equally important. Clients who reward innovation and sustainable practices are more likely to receive resource-optimised solutions. Aligning the project value chain—from client and designer to contractor and supplier—is required for effective design-stage resource optimisation.

### B. Procurement and Materials Management

Structural equation modelling was used in the study of procurement practices [8]. The research concluded that projects where procurement emphasised low-waste considerations—such as careful quantity checking, supplier selection based on packaging and delivery capability, and clear communication of waste-reduction goals—showed significantly lower material waste. The study showed that supplier commitment, measured through willingness to provide pre-cut materials and accept returns of unused items, had a strong influence on performance.

Other studies reinforce the main causes of material waste. Poor storage, design changes and inadequate supervision are some of the leading sources of waste in building projects [4]. Improving materials-management practices—such as using covered, well-organised storage areas, clearly labelling materials, and ensuring supervisors monitor handling practices—can reduce both damage and pilferage. Similar patterns were found in studies in Malaysia [14]. The evidence shows that procurement decisions are closely related to materials management. Material availability and waste generation can also be affected by inventory practices [10]. Structured stock-control systems help avoid both shortages and surpluses. When materials arrive exactly when needed and in appropriate quantities, crews are less likely to engage in “just in case” ordering, which leads to waste. The findings suggest that integrating waste-efficient procurement and materials-management practices into a broader resource-optimisation model is beneficial.

### C. Scheduling and Resource-Constrained Planning

Resource-constrained programming studies show a close link between balanced resource use and waste reduction. Tiwari et al. reviewed approaches that incorporate resource limits into schedule generation and argued that they produce more realistic programmes [9]. Balanced schedules reduce the need for overtime, temporary hires or last-minute adjustments. Smoother workflow makes it less likely that crews will be moved mid-task or that partially completed work will be exposed to damage. Abd et al. provided empirical evidence using Primavera P6 and supporting tools [10]. Alternative schedules resulted in shorter project duration and lower cost. These improvements were achieved without increasing the total amount of resources. Although the study did not directly measure waste quantities, the results are consistent with reduced waste.

Raja and Murali argued that resource management should not be treated as a one-time planning exercise but as an ongoing process of monitoring and adjustment [11]. Their model integrates resource planning and cost control. When resource-use trends show that certain crews or equipment are under-utilised, schedules can be revised and resources reallocated in ways that prevent wasted time and effort.

### D. Lean Production and Waste Reduction

Several studies examine the integration of lean construction principles. Lean methods and digital models can help identify and remove waste [7]. Value-stream mapping can reveal unnecessary information exchanges and handoffs, while model-based clash detection can prevent errors. Better visualisation makes it easier for site teams to understand resource constraints. Skoyles’ early work on waste prevention remains relevant today [12]. Practical measures such as ordering materials to match actual needs, training workers in careful handling, and providing adequate supervision were emphasised. Modern lean concepts and digital tools build on these fundamentals, but they cannot compensate for basic gaps in training, supervision and housekeeping.

Taken together, the evidence suggests that resource optimisation is both feasible and beneficial. When these strategies are integrated into project management approaches, they can be sustained across multiple projects rather than remaining isolated pilot initiatives.

## VII. IMPLEMENTATION CHALLENGES AND RECOMMENDATIONS

Implementing resource-optimisation strategies for waste reduction is not straightforward. Structural, cultural and technical barriers can slow or prevent change. Understanding these barriers is essential for designing realistic implementation plans. One major challenge is organisational and contractual fragmentation. A number of different entities hold responsibility for design, procurement and construction. Designers may not be present during construction and may receive limited feedback on the consequences of their decisions. In traditional design–bid–build arrangements, contractors have little say over supplier selection [4]. Clients and project sponsors can promote early contractor involvement, design–build contracts and partnering agreements. These arrangements encourage long-term thinking and joint problem-solving.

A second challenge concerns data and measurement gaps. Practices and tools that do not measure waste are difficult to justify. Initial effort is required to introduce measurement systems [2]. Once basic data are available, they often reveal opportunities for improvement. Tracking material deliveries and waste volumes can show which materials contribute most to cost overruns. A small set of indicators can make the process manageable. A third barrier is capability and culture. Designers may not be familiar with waste-minimisation guidelines, while planners and site managers may not be trained in lean methods. A culture that prioritises short-term cost minimisation over long-term value can discourage experimentation. Pilot projects can help shift attitudes. When teams experience tangible improvements, they are more motivated to continue these practices.

Technology integration presents a further challenge. The use of cost systems, models and scheduling tools is often disconnected. Schedules may not be linked to model elements or material quantities. Establishing integrated workflows requires changes in roles and technical setup. Actions such as keeping information up to date, assigning clear responsibility for maintaining digital models, and developing shared standards for representing resources and tasks may be needed [5]. In response to these challenges, several recommendations can be proposed. Project briefs and contracts should explicitly include targets for waste reduction and resource efficiency. Organisations should adopt internal guidelines for waste minimisation. Resource-constrained programming and structured site-logistics planning should be aligned with these goals [8]. Performance measurement systems should be reviewed regularly, and teams should be encouraged to document lessons learned to foster a culture of continuous improvement.

## VIII. CONCLUSION

Construction projects convert large quantities of materials, labour and energy into built assets, but a significant portion of these inputs is lost as waste due to poor planning, design and control. Waste should be seen as a signal of resource inefficiency, pointing to opportunities for improvement at every project stage. By examining construction waste through the lens of resource flows, it becomes clear that decisions made at the design desk, in the procurement office, and in planning meetings have as much influence on waste generation as the activities happening on the construction site itself.

The framework presented in this paper links resource-related decisions in design, procurement and planning, execution and feedback to the performance of the construction production system. Strategies such as design-for-waste-minimisation, waste-efficient procurement, resource-constrained scheduling, lean production control and BIM-enabled analysis are not isolated tools but components of a coherent approach to resource optimisation and waste reduction. Stage-wise strategy tables and key performance indicators, together with conceptual figures illustrating system interactions and resource flows, provide practical entry points for organisations seeking to implement these ideas. Building capability, filling information gaps and integrating digital tools into coordinated workflows are essential for successfully embedding resource optimisation into everyday practice. In return, lower material and labour costs, more predictable schedules, improved safety and reduced environmental impact are potential benefits. By treating each project as an opportunity to refine resource-optimisation practices, construction companies can move towards a mode of operation that is both cost-effective and socially responsible.

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