



Archives available at journals.mriindia.com

Multidisciplinary Journal of Research in Engineering and Technology

ISSN: 2348-6953

Volume 13 Issue 01, 2026

MATLAB-Based Linear Programming Techniques for Resource Optimization in Construction Management: A Review

Shivani Patil

Peer Review Information	Abstract
<p><i>Submission: 12 April 2026</i></p> <p><i>Revision: 02 May 2026</i></p> <p><i>Acceptance: 23 May 2026</i></p> <p>Keywords</p> <p><i>Linear Programming; MATLAB Optimization; Resource Allocation; Construction Management; Project Scheduling; Cost Optimization</i></p>	<p>The construction industry operates in highly resource-constrained environments where effective allocation of materials, labor, equipment, and financial resources directly influences project cost, duration, and productivity. Despite the widespread use of Linear Programming (LP) and Mixed-Integer Linear Programming (MILP) approaches in construction planning, limited review studies explicitly examine how these optimization models are integrated within MATLAB-based computational environments. With an emphasis on MATLAB-supported LP/MILP applications for resource optimization in construction management, this study provides an organized assessment of 25 research articles published between 2018 and 2025. Applications are divided into four categories by the review: integrated cost-time optimization frameworks, manpower allocation, material planning, and equipment scheduling. The use of solvers (especially MATLAB's linprog solver and Optimization Toolbox), methodological trends, and new developments toward multi-objective and digitally integrated optimization models are all critically examined. The results show that hybrid and resilience-oriented optimization frameworks are increasingly replacing deterministic single-objective models. Despite demonstrated computational efficiency and modeling flexibility, challenges remain in real-time implementation under dynamic site conditions. The study contributes by synthesizing recent advancements and identifying research gaps related to uncertainty modeling and digital construction integration, thereby providing guidance for future MATLAB-based optimization research in construction management.</p>

Introduction

Construction is one of the most resource-intensive industries and is characterized by complicated project settings, many different participants, and variances in cost, schedule, and resource availability(Lafhaj et al., 2024). To maximize construction management, the project manager must develop a concrete plan regarding the distribution of scarcer resources, such as construction materials, manpower, machines, and financial resources. Poor construction management may result in either an excessive use of construction materials or

prolonged efficiency delays in the construction project, therefore reducing the construction project's total income and overall performance (Okoh et al., 2024). As the construction project increases in overall size, these heuristics become insufficient. The objectives of overall construction time, total cost, and construction resource utilization become increasingly necessary. Construction projects are resource-sensitive due to constraints related to time, budget, and resource availability. In construction resource management, there are several objectives/metrics to manage, and

balancing these objectives is difficult. This is because an improvement in one objective may adversely affect another. Reducing the time needed for project completion may increase overall costs, while reducing the overall project

costs may increase the time needed for project completion (Mohamed et al., 2021). The construction project therefore requires the use of systematic planning and construction resource managerial techniques.

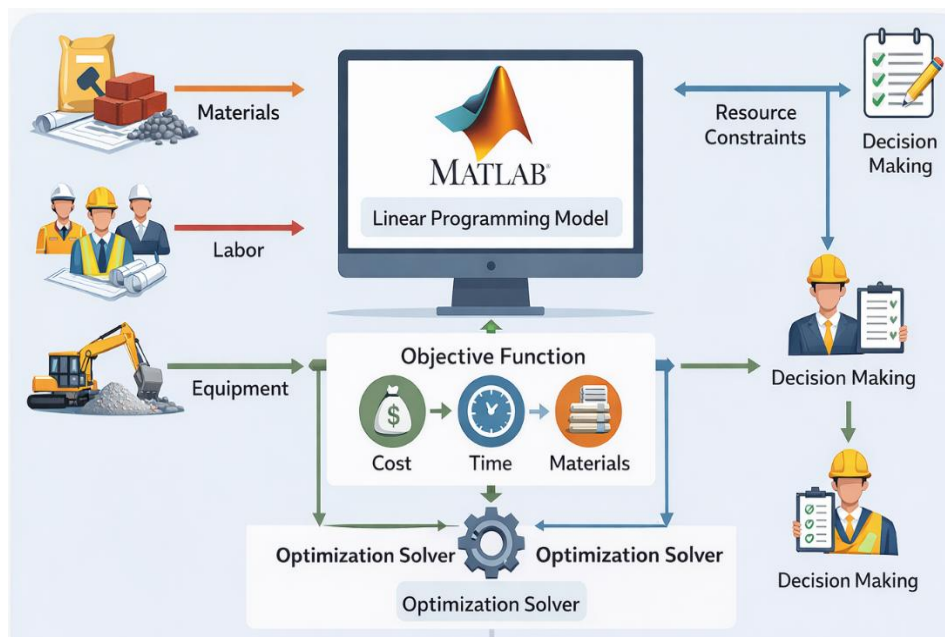


Figure 1. MATLAB-Based LP Framework for Construction Resource Allocation

Linear Programming (LP) is one of the optimization techniques that has been known and accepted in solving such resource allocation problems in construction management (Hegazi, 2024). As a construction manager, one of the objectives is to minimize the cost and maximize productivity. LP has a set of mathematical tools to assist in optimizing an objective function. This is subject to the constraints whereby the limitations are the resources, demands, and requirements of the project. Over time, LP has been used to material planning, labor scheduling, allocation of resources, transport logistics, and in construction projects, time–cost trade-off (Castro-Lacouture et al., 2009). Its ability to handle multiple constraints simultaneously and generate optimal solutions makes LP a valuable decision-support tool for construction managers (Aboelmagd, 2018). As a result of new developments in computational tools, MATLAB is commonly used to develop linear programming models in engineering and management. MATLAB's optimization toolboxes, built-in LP solvers like linprog, and its numerical precision and visualization tools aid in the formulation and solution of complex optimization problems. Its flexibility allows researchers and practitioners to model real-world construction scenarios efficiently, perform sensitivity analysis, and evaluate

alternative planning strategies with ease (Więckowski & Sałabun, 2024).

This review paper explores MATLAB-related linear programming optimal resource allocation techniques in construction management. Synthesizing research, this review highlights major application areas, critiques, offers advantages and disadvantages, and suggests further research (Hegazi, 2024). This paper, by reviewing the existing literature, illustrates MATLAB-related linear programming techniques and their role in enhancing the efficaciousness of decision-making in construction project management.

Review Methodology

The implementation of MATLAB-based Linear Programming (LP) and Mixed-Integer Linear Programming (MILP) techniques in construction management is examined in this study using an organized narrative review style. The review process was conducted in three systematic stages: literature identification, screening, and analytical categorization.

1. Literature Search Strategy

Relevant publications were identified using major academic databases, including Google Scholar and Scopus. The search was limited to peer-reviewed journal articles and conference papers published between 2018 and 2025 to

capture recent methodological developments. One foundational study published prior to 2018 was included to provide theoretical context. The search was conducted using combinations of the following keywords:

- Linear Programming in Construction
- MATLAB Optimization
- Mixed-Integer Linear Programming in Construction
- Resource Allocation in Construction
- Construction Scheduling Optimization
- MATLAB linprog solver

2. Screening and Selection Criteria

The identified articles were screened based on relevance, methodological rigor, and applicability to construction resource optimization. The following inclusion criteria were applied:

- Using LP or MILP models explicitly
- Use in circumstances related to construction management
- MATLAB or similar computational frameworks are used for implementation.
- Clear formulation of objective functions and constraints
- Articles were excluded if they:
- Purely theoretical mathematical modelling with no relevance to construction
- Employed metaheuristic or heuristic techniques without LP/MILP formulation
- Not clear enough in terms of methodology
- Twenty-five extremely pertinent papers were chosen for in-depth examination after screening and eliminating duplicates.

3. Analytical Framework

The selected studies were systematically analyzed and divided into four key application domains:

- Material resource planning
- Workforce allocation
- Equipment scheduling
- Integrated cost-time optimization

The review further examined solver usage (particularly MATLAB's linprog function), model characteristics (single vs multi-objective), treatment of uncertainty, and emerging integration with digital construction technologies. Finding methodological trends, research gaps, and real-world application issues are the main objectives of the synthesis.

Linear Programming in Construction Management

Linear programming can be defined as a set of mathematical techniques concerned with the optimization of a given situation that involves the allocation of scarce resources among a number of competing activities (Kunwar & Sapkota, 2022). In construction management, linear programming helps achieve systematic and rational decision-making during the planning and control phases. Generally, linear programming consists of formulating an objective function whereby a decision maker attempts to minimize project costs and/or project completion times, while satisfying a given set of linear constraints that pertain to the availability of materials, manpower, equipment, finances, and schedules (Dr. Amilal Kulhari, 2023). In construction, most practitioners seek to minimize one or more of the following: costs, times, quantities of materials, and/or enhance overall productivity. Construction constraints include resource availability, completion time, and operational restrictions. Construction management may involve various kinds of linear programming models to address a problem: models and activities control of material allocation, labor scheduling, equipment usage, transportation and logistics, time-cost trade-off analysis, etc (Ramani et al., 2024). Because of its construction application, the Simplex and assignment methods tend to be more frequent because these are reliable and efficient for construction problems.

Relative to conventional strategic methodologies anchored in manual computations and experiential knowledge, LP presents a series of advancements (Zeng & Jia, 2024). These include optimal and clear answers, the ability to tackle several constraints at once, and a reduction in planning errors and facilitation of more reliable decision making. The aforementioned advantages make LP beneficial for enhancing efficiency, controlling costs, and resource allocation in contemporary construction projects.

1. Role of Linear Programming in Construction Planning

Linear Programming (LP) techniques contribute to construction planning by providing an analytical means to optimize the allocation of various resources (Kalwar et al., 2022). Construction involves many interdependent activities competing for resources that may include materials, labor, equipment, and time. With the aid of LP, construction project managers are able to develop a planning alternative and assess the allocation of

resources that will help achieve the project goals and stay within the parameters of the constraints. LP, by mathematically representing planning problems, assists in estimating the resources needed and aids in optimal decision making. LP aids in cost minimization, time of completion reduction, and overall improved productivity, while also improving the quality of the processes/ activities within the project (Ahmad & Kamruzzaman, 2025). LP may help the planner evaluate differing resource availability and overall project conditions optimistically. In construction management, the use of LP means planning can be completed with less uncertainty and more accuracy, which means a higher degree of control over the construction process.

MATLAB for Solving Linear Programming Problems

MATLAB is a highly flexible, versatile, and widely used computational environment for solving linear programming (LP) problems especially for construction management (Rawan, 2025). Because of its highly developed numerical computation, smooth model formulation, and specialized optimization tools, it has become an industry standard among engineers and researchers dealing with difficult engineering optimization problems. In construction management, problems related to LP tackling resource management, cost management, and scheduling can easily be modelled using matrix formulations coupled with vector formations and serviced by MATLAB constructing objective functions, and defining constraints. One of MATLAB's most important features is its Optimization Toolbox which allows for the solving of linear and nonlinear optimization problems. With this Toolbox, construction middle managers can define their objectives, constraints (both inequalities and equality), and bounds on their variables, which accurately mirrors the situation they are trying to optimize for real life construction planning problems. MATLAB is especially suited for construction problems which necessitate the use of a matrix tool and involve considerable amounts of data related to various construction resources, construction activities, and construction constraints (Qazi et al., 2021). MATLAB is highly numerical and computational to ensure that the solutions it provides for these LP construction models are reliable.

The linprog function in MATLAB is the most widely used LP solver in construction management. It can solve many types of construction management optimization problems such as scheduling, resource

allocation, and cost minimization (Aboelmagd, 2018). linprog employs sophisticated optimization techniques to solve these types of problems. Because construction problems are often complex and involve multiple sets of resources and variables, linprog's ability to incorporate one or more of the following along with inequalities and other operational constraints is quite useful: equality constraints, upper and lower bounds, and optional parameters. Aside from its additional modeling capabilities, there are many reasons to utilize MATLAB in planning construction with LP (Arif & Khan, 2021). It alleviates the burden of manually calculating construction resources (i.e. labor, materials, equipment, and their associated costs), decreases the likelihood of human and computational errors for planning and scheduling LP, and manages large volumes of construction planning data. It is also more efficient as variables and parameters can be reset to perform sensitivity analyses and modify constraints as resources, deadlines, and their associated costs change.

Besides optimization functions, MATLAB offers visualization tools that facilitate the interpretation of results. Outputs of optimization can be depicted in graphs, plots, and charts which help construction managers to understand their patterns and the trade-offs associated with resource management (Ding et al., 2024). These features aid construction managers to make better decisions and improve construction management functions.

Applications of MATLAB-Based Linear Programming in Construction

Linear programming (LP) techniques based on MATLAB have been applied in many fields of construction management for improving efficiency, cost reduction, and decision-making (Manoharan et al., 2022). Construction planning problems can be formulated as optimization models to help TEC (Technology, Engineering, Construction) systematically assess allocation of resources under real-world constraints.

1. Material Resource Allocation

The optimization of resource allocation is one of the most widely used applications of Linear Programming (LP) in the field of construction management. LP Models in MATLAB aid in the optimization of the procurement and use of construction materials (Ghamari et al., 2024). This includes cement, steel, aggregates, and bricks. Most of the time the objective is to minimize the costs of construction materials and wastage while still complying with the project

demand and availability constraints. These models assist construction managers in efficiently planning and controlling the materials and quantities to be supplied to the

construction site, thereby reducing the construction excess inventory. They also ensure a timely supply to the construction site.

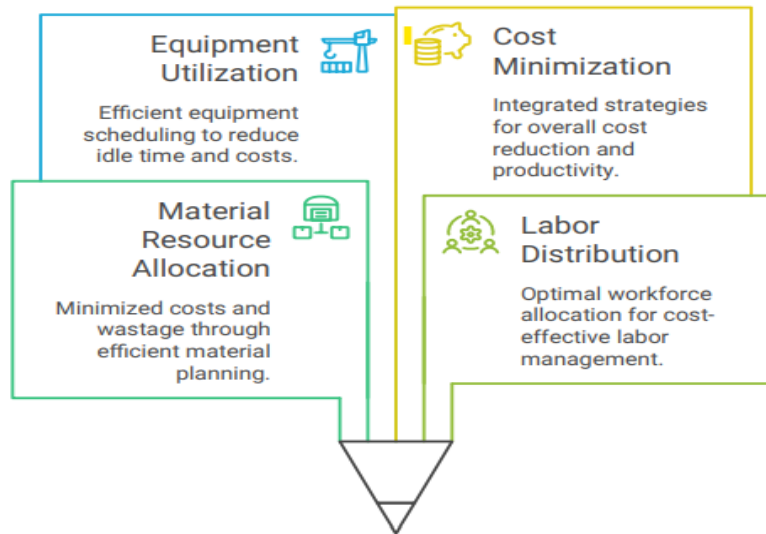


Figure 2. Applications of MATLAB-Based LP in Construction Management

2. Labor Distribution and Workforce Planning

It is important to consider labor management in construction because of differences in skill, productivity, and availability. LP in MATLAB allocates skilled and unskilled labor to different activities, minimizing costs while ensuring no labor is wasted and no overtime is required. LP simplifies workforce planning and improves productivity, given the constraints of working hours, the skill required to satisfy, and the deadline of the activities (Al-Rawi & Mukherjee, 2019).

3. Equipment Utilization and Scheduling

As construction equipment is a key asset, it needs to be employed effectively. In this regard, LP models used in MATLAB facilitate the scheduling of equipment to reduce downtime and cut costs. These models support determining the best machine quantities and the distribution of machines to various tasks in a project, thereby enhancing the synchronization of equipment supply and the timelines of project activities.

4. Cost Minimization and Productivity Improvement

In construction projects, overall cost minimization and productivity enhancement can be achieved by applying LP techniques using MATLAB. LP models pinpoint construction strategies by allocating costs, in which materials, labor, and equipment are merged under a singular optimization framework (J. Tang et al., 2024). Such an approach boosts the positive results of a construction project, including the

utilization of resources, the reduction of time taken for completion, and productivity enhancement. Ultimately, this integrated approach increases the profitability of the construction project.

Related Work

The most current studies have demonstrated a distinct transition toward reliance on optimization and resource allocation, construction planning simplifications, linear programming, and mixed-integer linear programming, frequently facilitated by various computational tools (including MATLAB implementations for solving LP (Linear Programming) subproblems). In construction scheduling for integrated multi-projects and supply chains, Abdzadeh (2022) formulated a project scheduling, supplier selection, and transportation routing derivative model at the construction supply chain cost balance level utilizing MILP (Mixed Integer Linear Programming) for overall cost balance (Abdzadeh et al., 2022). In adaptive project control, Teuber et al. (2024) offered a “dynamic” decision support model for “on-the-run” scheduling control – optimization-based planning, in real infrastructure situations, helps support corrective actions during the absence of full certainty and the intricacies of unfulfilled contracts. Workforce optimization post COVID-19 disruptions received the most attention (Teuber et al., 2024). For example, Corral et al. (2023) demonstrated the use optimization in construction project workforce

scheduling under social distancing by formulating a construction project workforce scheduling model with distance constraints in construction in which he quantified trade-offs for managerial control purposes between non-worked paid hours and over-work hours(Corral et al., 2023).

Recent studies that focus on optimizing linear construction schedule are also studying how to better improve the flow of construction activities and how to minimize idle resources. Tang et.al (2018) studied the optimization of scheduling in linear construction and the demand of scheduling focus on the continuity of resource allocation to minimize loss in productivity and increase in costs during linear construction(Y. Tang et al., 2018). Following this studies focus, Altanany et.al (2024) used NSGA-II to optimize time-cost and matrix-based modeling of linear scheduling methods (LSM), which extended the modeling foundation of linear project time-cost optimization(Altanany et al., 2024). Klein et.al (2024) introduced linear resource-constrained scheduling optimization with a new, more compact, and efficient MILP for project scheduling with resource limitations (of any sort) and showed he provided better computation resources than the referenced MILPs(Klein et al., 2024). Taken as a whole, the studies outline construction scheduling in the modern age is converging to the idea of using MILP methods to manage intricate relations of precedence, complex, and intersecting constraints of both renewable and non-renewable resources.

There has also been an increase in the scope of applications in logistics operations and construction. In ready-mixed concrete operations, for example, Tibaldo et. Al. (2025) developed an integrated MILP model for coordinating batching, production, fleet

dispatch, and time window constrained deliveries. scheduling(Tibaldo et al., 2025). Beyond site operations, construction supply chains motivate modular/manufacturing-driven construction supply chains structured for modular manufacturing supply chain most construction industrialization. Supply chain modular manufacturing Feasibility analysis, construction industrialization, procurement-production-logistics, construction, industrialization, procurement, production, logistics, construction, industrialization, construction, Peiris (2023) examined robust scheduling of construction projects, and the focus of the study was the variability in resources and the need to account for the variability rather than the reliance on a deterministic plan(Peiris et al., 2023). In the earlier part of the time window, Albayati and Aminbakhsh (2023) represents the broader research focused on the scheduling and allocation of construction projects(Albayati & Aminbakhsh, 2023). The overall movement toward more precise allocation based on optimization, rather than heuristic methods, is supported by the use mixed-integer programming in a multi-project framework. In summary, the available research for the years 2020-2025 indicates that there is an increasing trend for the use of LP/MILP based allocation methods in the construction industry. There is a trend for the use of LP/MILP methods to increase the transparency, efficiency, and overall constructability of planning in construction. The research for the years 2020-2025 has shown that integrating scheduling, logistics, continuity, and resilience is a construction-oriented trend.

A summary of selected MATLAB-based Linear Programming applications in construction management is presented in Table 1.

Table 1. Summary of MATLAB-Based Linear Programming Applications in Construction Management

Author(s)	Year	Application Area	Optimization Model	Main Findings
Aboelmagd	2018	Construction site resource allocation	LP	Demonstrated cost minimization using LP models in construction projects.
Mohamed et al.	2021	Project delivery time reduction	LP	Developed resource-constrained scheduling approach to reduce completion time.
Ramani et al.	2024	Time-cost-storage optimization	LP	Proposed LP framework for balancing cost and storage constraints.
Klein et al.	2024	Resource-constrained project scheduling	MILP	Improved computational efficiency for large-scale

				scheduling problems.
Corral et al.	2023	Workforce scheduling	Multi-objective LP	Optimized labor allocation under COVID-related constraints.
Tibaldo et al.	2025	Concrete production & logistics	MILP	Integrated batching, routing, and time-window constraints.
Ghamari et al.	2024	Sustainable material supply chain	MILP	Developed optimization framework for sustainable material planning.
Ding et al.	2024	Labor resource optimization	LP	Applied risk-based optimization for labor allocation decisions.

Discussion

1. Research Gaps and Future Directions

Although existing studies demonstrate the effectiveness of Linear Programming (LP) and Mixed-Integer Linear Programming (MILP) models in construction resource allocation, several research gaps remain. First, while numerous studies focus on single-objective optimization such as cost minimization or time reduction, limited research integrates multi-objective trade-offs involving cost, time, sustainability, and productivity simultaneously. Second, most LP models are developed under deterministic assumptions, with insufficient consideration of uncertainty, dynamic site conditions, and real-time data variability. Third, despite MATLAB's strong computational capabilities, relatively few studies explore its integration with emerging digital construction technologies such as Building Information Modeling (BIM), Internet of Things (IoT), and real-time monitoring systems. Furthermore, practical implementation challenges—including technical expertise requirements and data availability constraints—are not extensively addressed in the literature. Future research should therefore emphasize hybrid optimization frameworks, real-time adaptive LP models, and integration with digital construction platforms to enhance decision-support capabilities in complex project environments.

2. Practical Implications

The construction industry involves complex decision-making processes that require structured quantitative support. MATLAB-based Linear Programming (LP) models provide construction managers with systematic tools to convert practical planning problems—such as material distribution, workforce scheduling, and equipment allocation—into solvable mathematical formulations. The use of MATLAB's optimization capabilities enhances planning precision, reduces reliance on heuristic decision-making, and improves control over scheduling and financial constraints. Its ability

to process large datasets and perform sensitivity analysis further strengthens decision accuracy and resource utilization efficiency.

However, practical implementation of LP models in construction projects remains challenging. Construction environments are dynamic, with frequent changes in site conditions, resource availability, and stakeholder requirements. Since many LP models rely on deterministic data, continuous updating is necessary to maintain relevance. Additionally, limited technical expertise and resistance to adopting mathematical optimization tools may hinder practical application. Integrating LP models with real-time data systems, digital construction platforms, and advanced analytics presents significant opportunities for improving applicability and effectiveness in modern construction management.

Conclusion

This review examined the role of MATLAB-based Linear Programming (LP) and Mixed-Integer Linear Programming (MILP) techniques in optimizing resource allocation within construction management. The examination of a few chosen studies shows that LP models offer quantitative and organized assistance for decision-making in areas including cost-time optimization, manpower allocation, material planning, and equipment scheduling. In complex building situations, MATLAB's computational capabilities—such as its Optimization Toolbox and solver functions—improve modelling efficiency, numerical reliability, and sensitivity analysis.

The results show that integrated and multi-resource optimization frameworks for building projects are becoming more and more popular in research. Nevertheless, there are also practical implementation issues, especially when it comes to dealing with unpredictability, changing site circumstances, and a lack of technical experience. Stronger integration with

digital technologies, real-time data systems, and adaptive optimization techniques are necessary to close the gap between theoretical optimization models and practical construction practices.

Overall, MATLAB-based LP techniques represent a promising pathway toward more data-driven, efficient, and resilient construction management practices, particularly as the industry continues its transition toward digitalization and intelligent project planning.

References

Tibaldo, A. S., Montagna, J. M., & Fumero, Y. (2025). Efficient mixed-integer linear programming model for integrated management of ready-mixed concrete production and distribution. *Automation in Construction*, *173*, 106074.

<https://doi.org/10.1016/j.autcon.2025.106074>

Altanany, M. Y., Badawy, M., Ebrahim, G. A., & Ehab, A. (2024). Modeling and optimizing linear projects using LSM and Non-dominated Sorting Genetic Algorithm (NSGA-II). *Automation in Construction*, *165*, 105567.

<https://doi.org/10.1016/j.autcon.2024.105567>.

Ding, F., Liu, M., Hsiang, S. M., Hu, P., Zhang, Y., & Jiang, K. (2024). Duration and Labor Resource Optimization for Construction Projects—A Conditional-Value-at-Risk-Based Analysis. *Buildings*, *14*(2), 553.

<https://doi.org/10.3390/buildings14020553>.

Ghamari, H., Abbasianjahromi, H., & Mirhosseini, S. M. (2024). Providing a framework to optimize the sustainable construction material supply chain with the possibility of horizontal transfers. *Sustainable Futures*, *8*, 100328.

<https://doi.org/10.1016/j.sftr.2024.100328>.

Hegazi, M. O. (2024). A novel approach for simulating and optimizing the production costing system. *Heliyon*, *10*(24), e40932.

<https://doi.org/10.1016/j.heliyon.2024.e40932>.

Klein, N., Gnägi, M., & Trautmann, N. (2024). Mixed-integer linear programming for project scheduling under various resource constraints. *European Journal of Operational Research*, *319*(1), 79–88.

<https://doi.org/10.1016/j.ejor.2024.06.036>.

Lafhaj, Z., Rebai, S., Albalkhy, W., Hamdi, O., Mossman, A., & Alves Da Costa, A. (2024). Complexity in Construction Projects: A Literature Review. *Buildings*, *14*(3), 680.

<https://doi.org/10.3390/buildings14030680>.

Okoh, O. F., Ukpoju, E. A., Otakwu, A., Ayoola, V. B., & Enyejo, L. A. (2024). CONSTRUCTION MANAGEMENT: SOME ISSUES IN THE CONSTRUCTION PROJECT. *Engineering Heritage Journal*, *8*(1), 42–50.

<https://doi.org/10.26480/gwk.01.2024.42.50>.

Teuber, L. G., Van Heukelum, H., & Wolfert, R. (2024). *Advancing Strategic Planning and Dynamic Control of Complex Projects*. SSRN.

<https://doi.org/10.2139/ssrn.4946911>

Więckowski, J., & Sałabun, W. (2024). A new sensitivity analysis method for decision-making with multiple parameters modification. *Information Sciences*, *678*, 120902.

<https://doi.org/10.1016/j.ins.2024.120902>

Ramani, P. V., Kandasamy, S., Gupta, A., & Ms, S. (2024, June 3). *Developing Time-Cost & Storage Optimization Model for a Construction Project A Linear Programming Approach*. 41st International Symposium on Automation and Robotics in Construction, Lille, France.

<https://doi.org/10.22260/ISARC2024/0060>

Albayati, N. H. F., & Aminbakhsh, S. (2023). Resource allocation capabilities of commercial project management software packages for resource leveling and resource constrained project scheduling problems: A comparative study. *Journal of Construction Engineering, Management & Innovation*, *6*(2), 104–123.

<https://doi.org/10.31462/jcemi.2023.02104123>.

Corral, F., Forcael, E., & Linfati, R. (2023). Workforce scheduling efficiency assessment in construction projects through a multi-objective optimization model in the COVID-19 context. *Heliyon*, *9*(6), e16745.

<https://doi.org/10.1016/j.heliyon.2023.e16745>

Dr. Amilal Kulhari. (2023). Significance of Linear Programming for Optimization. *International Journal of Advanced Research in Science, Communication and Technology*, 179–186.

<https://doi.org/10.48175/IJARSC-10899>

Peiris, A., Hui, F. K. P., Duffield, C., & Ngo, T. (2023). Production scheduling in modular construction: Metaheuristics and future directions. *Automation in Construction*, *150*, 104851.

<https://doi.org/10.1016/j.autcon.2023.104851>

Abdzadeh, B., Noori, S., & Ghannadpour, S. F. (2022). Simultaneous scheduling of multiple construction projects considering supplier selection and material transportation routing.

Automation in Construction, 140, 104336.
<https://doi.org/10.1016/j.autcon.2022.104336>

Kunwar, R., & Sapkota, H. P. (2022). Introduction to Linear Programming Problems with Some Real-Life Applications. *European Journal of Mathematics and Statistics*, 3(2), 21–27.
<https://doi.org/10.24018/ejmath.2022.3.2.108>

Manoharan, S., Stilling, D., Kabir, G., & Sarker, S. (2022). Implementation of Linear Programming and Decision-Making Model for the Improvement of Warehouse Utilization. *Applied System Innovation*, 5(2), 33.
<https://doi.org/10.3390/asi5020033>

Arif, F., & Khan, W. A. (2021). Smart Progress Monitoring Framework for Building Construction Elements Using Videography–MATLAB–BIM Integration. *International Journal of Civil Engineering*, 19(6), 717–732.
<https://doi.org/10.1007/s40999-021-00601-3>

Mohamed, H. H., Ibrahim, A. H., & Soliman, A. A. (2021). Toward Reducing Construction Project Delivery Time under Limited Resources. *Sustainability*, 13(19), 11035.
<https://doi.org/10.3390/su131911035>

Qazi, A., Shamayleh, A., El-Sayegh, S., & Formanek, S. (2021). Prioritizing risks in sustainable construction projects using a risk matrix-based Monte Carlo Simulation approach.

Sustainable Cities and Society, 65, 102576.
<https://doi.org/10.1016/j.scs.2020.102576>

Al-Rawi, O. Y. M., & Mukherjee, T. (2019). Application of Linear Programming in Optimizing Labour Scheduling. *Journal of Mathematical Finance*, 09(03), 272–285.
<https://doi.org/10.4236/jmf.2019.93016>

Aboelmagd, Y. M. R. (2018). Linear programming applications in construction sites. *Alexandria Engineering Journal*, 57(4), 4177–4187.
<https://doi.org/10.1016/j.aej.2018.11.006>

Tang, Y., Liu, R., Wang, F., Sun, Q., & Kandil, A. A. (2018). Scheduling Optimization of Linear Schedule with Constraint Programming. *Computer-Aided Civil and Infrastructure Engineering*, 33(2), 124–151.
<https://doi.org/10.1111/mice.12277>

Castro-Lacouture, D., Süer, G. A., Gonzalez-Joaqui, J., & Yates, J. K. (2009). Construction Project Scheduling with Time, Cost, and Material Restrictions Using Fuzzy Mathematical Models and Critical Path Method. *Journal of Construction Engineering and Management*, 135(10), 1096–1104. [https://doi.org/10.1061/\(ASCE\)0733-9364\(2009\)135:10\(1096\)](https://doi.org/10.1061/(ASCE)0733-9364(2009)135:10(1096))