THE ROLES OF NETWORK ANALYSIS IN BUILDING PROJECT: THE STRATEGIC ADOPTION AND CHALLENGES

By

AKPAN, E. Ebenezer, Ph.D. FCICN, AP, PPGDCA, PHDCDPM
Corporate Institute of Research and Computer Science
140 Ikot Ekpene Road
Uyo, Akwa Ibom State

And

Bernard U. Anthony Ph.D.
Faculty of Business Management
University of Rochester
Rochester
New York City

Abstract

This study explored the roles of network analysis in building projects, exploring its strategic adoption and challenges. The study mentioned that the construction industry is a complex ecosystem where the success of building projects hinges on meticulous planning, efficient resource allocation, and timely execution. In this intricate landscape, network analysis emerges as a powerful tool that provides strategic frameworks for optimising project schedules, managing dependencies, and mitigating risks. In carrying out this research, numerous subheads were taken into account, some of which included the concept of network analysis, the concept of building projects, and types of network analysis for building projects. The study mentioned the types of network analysis for building projects to include the critical path method (CPM), program evaluation/review technique (PERT), and dependency structure matrix (DSM), among many others. It further mentioned project scheduling, time management, resource optimisation, and cost control, among many others to be the roles of network analysis in building projects. The study mentioned the strategic ways of using network analysis for building projects to include, among others, developing a comprehensive project plan and identifying critical tasks/dependencies. Moreover, the challenges encountered using network analysis for building projects as highlighted in the study included: complexity in large-scale projects and time-consuming data collection/analysis. The research also proffered mitigations to the challenges encountered using network analysis for building projects to include simplifying complex projects and investing in training/capacity building. The study concluded that the construction industry demands meticulous planning, efficient resource allocation, and timely execution for project success. One of the recommendations was that to maximise the benefits of network analysis in building projects, stakeholders should invest in training and capacity-building initiatives.

Keywords: Network Analysis and Building Project, Strategic Adoption and Challenges

Introduction

The construction industry is a complex ecosystem where the success of building projects hinges on meticulous planning, efficient resource allocation, and timely execution. In this intricate landscape, network analysis emerges as a powerful tool that provides strategic frameworks for optimising project schedules, managing

dependencies, and mitigating risks (Akinola & Udo, 2020). With its ability to model and analyse intricate interdependencies among project tasks, network analysis enhances decision-making, ensuring that projects are delivered on time and within budget. This study delves into the transformative roles of network analysis in building projects, focusing on its strategic adoption and the challenges that accompany its implementation.

At its core, network analysis offers a structured approach to visualising and managing the interconnections among various project activities. Techniques such as the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT) have revolutionised how project managers identify task sequences, allocate resources, and anticipate potential bottlenecks (Olowo & Eze, 2019). These tools not only enhance the efficiency of project workflows but also empower stakeholders to adapt to uncertainties, thereby reducing the likelihood of costly delays and disruptions. As construction projects grow in complexity, the integration of network analysis becomes increasingly indispensable.

One of the strategic advantages of network analysis lies in its capacity to align project goals with available resources and constraints. By enabling the creation of dynamic project schedules, network analysis ensures that all activities are synchronised, from material procurement to labour deployment to ensure effective project delivery (Ekanem & John, 2021 and Amuzat & Eno, 2024). This synchronisation is particularly crucial in building projects, where even minor delays can cascade into significant financial losses. Furthermore, network analysis provides real-time insights, allowing project managers to make informed adjustments and maintain operational efficiency throughout the project lifecycle.

However, the adoption of network analysis in building projects is not without challenges. Issues such as insufficient technical expertise, high implementation costs, and resistance to change can hinder its widespread application (Adedokun et al., 2020). Additionally, the accuracy of network analysis depends on the quality of input data, making it susceptible to errors in task estimation and resource allocation. These challenges underscore the need for robust training programs, data validation techniques, and organisational support to maximise the benefits of network analysis.

Despite these challenges, the strategic potential of network analysis in building projects cannot be overstated. Its ability to streamline complex processes, enhance collaboration, and foster proactive risk management makes it a cornerstone of modern construction practices. By addressing implementation barriers and leveraging technological advancements, the construction industry can unlock the full potential of network analysis, driving innovation and efficiency.

Concept of Network Analysis

In a building project, "network analysis" refers to a project management technique that uses a graphical diagram to visualise the sequence of all project activities, their dependencies on each other, and their estimated durations, allowing project managers to identify the critical path (the longest sequence of tasks that determines the overall project completion time) and effectively plan, schedule, and monitor the project to ensure timely completion within budget and quality standards.

Oladimeji, Akomolafe, Lasisi, Oloja, and Oladimeji (2023) explained that network analysis in building construction refers to the use of mathematical models to analyse and optimise the flow of materials, information, and resources in a construction project. Network analysis is widely used in construction projects to improve efficiency and reduce costs. The use of network analysis tools such as PERT (Program Evaluation and Review Technique), CPM (Critical Path Method), and Gantt Charts can help project managers to identify critical activities, schedule and budget constraints, and potential risks.

Network analysis is a powerful tool for planning and managing construction projects. It helps identify the critical path, estimate the duration and cost, and optimise the resources and risks of a project. Network analysis is a technique used for planning and scheduling large projects in the fields of construction, maintenance, fabrication, purchasing, computer system instantiation, research and development planning, etc. Network analysis is one of the important quantitative techniques in the process of effective management decision-making.

According to Senthinathan (2012), network analysis is a technique for planning and controlling. Network analysis is a basic terminology consisting of a set of techniques that has been developed for planning and controlling of projects in view of facilitating the management of an organization. Network analysis is a structured process that reveals and visualises the connections and relationships between stakeholders. It uses graphical representations to visualise the networks of interactions, influences, and communication channels.

Concept of Building Project

A building is an enclosed space, such a house or factory, that has walls and a roof and is typically stationary. Buildings may be found in a wide range of sizes, forms, and purposes (Usanga and Usanga, 2024). A building project refers to a planned undertaking, with a defined scope and timeline, to construct, renovate, or modify a building, encompassing all stages from initial design and planning through procurement of materials, construction work, and final completion, aiming to deliver a functional and finished structure within a specific budget and timeframe. Building Project means the construction, reconstruction, repair, alteration, improvement, or extension of buildings, structures, or facility constructed or acquired. Building project also require that the project manager adhere to the relevant health and safety standard in in order to prevent disasters (Amuzat & Eno, 2024).

https://www.letsbuild.com/blog/6-stages-of-a-project-in-construction

According to Designing Buildings Ltd. (2025), a building project is an organised process of constructing, renovating, refurbishing, retrofitting, or adapting a building or other built assets. Building project means the construction, reconstruction, repair, alteration, improvement, or extension of any building, structure, or facility constructed or acquired (Law Insider, 2025). According to Proest (2022), cited in Usanga and Edem (2024) building project is the physical activity on a construction site that contributes to building or structure construction.

Building project refers to the process of assembling materials, labour, and equipment to create structures that serve various purposes, including residential, commercial, and industrial. It encompasses a wide range of activities, from site preparation and foundation laying to erecting walls, installing utilities, and finishing interiors. Building projects are multifaceted processes that involve meticulous planning, precise execution, and adherence to safety regulations.

Types of Network Analysis for Building Project

Network analysis is a critical tool in project management, particularly for building projects, as it helps organise, plan, and monitor the activities necessary for successful project completion. Below are the primary types of network analysis techniques used in building projects:

Critical Path Method (CPM): CPM is a widely used technique that identifies the longest sequence of dependent tasks in a project, known as the "critical path." This method helps project managers determine the minimum project duration, prioritise tasks, and allocate resources efficiently (Oladimeji, Akomolafe, Lasisi, Oloja, and Oladimeji, 2023). CPM is particularly useful in building projects to identify potential delays and optimise the construction schedule.

Program Evaluation and Review Technique (PERT): PERT focuses on handling uncertain project timelines by using three time estimates: optimistic, pessimistic, and most likely durations for each task (Oladimeji, Akomolafe, Lasisi, Oloja, and Oladimeji, 2023). This probabilistic approach is valuable in building projects where uncertainties like weather conditions or material delivery delays may arise, enabling managers to predict potential risks and adjust plans accordingly.

Dependency Structure Matrix (DSM): DSM is a compact and visual representation of task dependencies. It helps in identifying iterative tasks and optimising workflows in building projects. This method is particularly beneficial in managing complex interactions among various construction activities and ensuring that no step is overlooked (Browning, 2015).

Line of Balance (LOB): LOB is used for repetitive construction tasks, such as high-rise buildings or pipeline installations. It ensures that resources are synchronised across different activities to maintain a steady workflow. This technique is effective in managing tasks that require a continuous sequence of operations.

Gantt Chart Analysis: Although not a pure network analysis method, Gantt charts visually display project schedules, showing task durations and overlaps. They help

project managers track progress and ensure that tasks align with the overall timeline, making it a complementary tool in building projects.

Precedence Diagram Method (PDM): PDM is a graphical representation of tasks using nodes and arrows to show their relationships. It identifies dependencies such as "finish-to-start" or "start-to-start," allowing project managers to visualise and manage task sequences effectively in building projects.

The Roles of Network Analysis in Building Project

The following are the roles of network analysis in building project as mentioned by numerous scholars including Adebowale and Oluboyede (2011):

Project Scheduling and Time Management: Network analysis provides a structured approach to scheduling construction activities. By identifying task sequences and their dependencies, it determines the critical path—the longest sequence of activities that dictates the project's minimum duration. This information allows project managers to prioritize tasks, allocate resources efficiently, and anticipate potential delays, ensuring timely completion of the project.

Resource Optimization and Cost Control: Through network analysis, construction projects can optimize the use of labor, materials, and equipment. It identifies periods of high resource demand and enables resource leveling to avoid wastage. Additionally, network analysis prevents overlapping or redundant activities, reducing unnecessary expenses and ensuring that the project remains within budget.

Risk Management and Decision-Making: Network analysis incorporates uncertainties and potential risks into project planning. By evaluating the impact of risks on timelines and outcomes, it supports the development of contingency plans (Hu, Xie and Cai, 2024). This enables proactive decision-making to mitigate disruptions caused by unforeseen events, ensuring smoother project execution.

Improved Communication and Stakeholder Alignment: The visual representation of activities and dependencies in network diagrams enhances communication among stakeholders. It provides a clear overview of the project plan, fostering collaboration and alignment on project goals. This clarity helps prevent misunderstandings and promotes a shared understanding of timelines and responsibilities.

Performance Monitoring and Evaluation: Network analysis serves as a benchmark for tracking project progress. By comparing actual outcomes with planned schedules, project managers can identify deviations, assess their causes, and take corrective actions. This ensures accountability, improves performance, and maintains the project's quality and reliability.

The Strategic ways of Using Network Analysis for Building Project

Network analysis is a powerful tool that helps streamline building project management by organising tasks, optimising resources, and identifying potential risks. Here are strategic ways to effectively use network analysis for building projects:

Developing a Comprehensive Project Plan: Network analysis enables project managers to map out all tasks and activities required to complete a building project. By using techniques like the Critical Path Method (CPM) or Program Evaluation and Review Technique (PERT), teams can create a clear and detailed project roadmap, ensuring no task is overlooked (Bagshaw, 2021).

Identifying Critical Tasks and Dependencies: Strategically applying network analysis helps identify critical tasks and their dependencies (Teamhub, 2024). This ensures project managers know which tasks require immediate attention and which can be delayed without impacting the overall timeline. This focus minimises risks of delays and resource misallocation.

Optimizing Resource Allocation: With network analysis, project managers can allocate labor, materials, and equipment more efficiently. Techniques such as Line of Balance (LOB) ensure that resources are used optimally, particularly for repetitive tasks, preventing downtime and reducing waste (Arditi, Tokdemir and Suh, 2002).

Improving Risk Management: Through PERT and CPM, project managers can predict potential delays or bottlenecks. For instance, using PERT's probabilistic time estimates, teams can prepare contingency plans to address uncertainties like weather disruptions or supply chain issues.

Enhancing Communication and Collaboration: Network diagrams, Gantt charts, and Precedence Diagram Methods (PDM) provide visual representations of project schedules and task relationships. These tools promote better understanding among stakeholders, including contractors, architects, and clients, fostering teamwork and accountability (Richard, 2024).

Monitoring Progress and Performance: Network analysis allows for continuous tracking of project progress against planned schedules. Project managers can use baseline comparisons to identify deviations early and take corrective actions to keep the project on track.

Ensuring Efficient Workflow Management: Dependency Structure Matrix (DSM) and Precedence Diagram Method (PDM) help optimize workflows by identifying task dependencies and sequencing them effectively. This prevents rework and ensures a logical progression of construction activities (Maheswari, Varghese and Sridharan, 2006).

Facilitating Decision-Making: Strategic application of network analysis provides data-driven insights for decision-making. By understanding critical paths and resource constraints, managers can make informed choices about project adjustments, resource reallocations, or timeline extensions.

The Challenges encountered using Network Analysis for Building Project

While network analysis is a valuable tool for managing building projects, its application can present several challenges. These issues may arise from the complexity of construction activities, resource constraints, or mismanagement. Here are the primary challenges encountered as mentioned by numerous scholars, including Adebowale and Oluboyede (2011):

Complexity in Large-Scale Projects: Building projects often involve numerous interdependent tasks, making the creation and management of comprehensive network diagrams difficult. As the scale of the project increases, managing the intricacies of task dependencies becomes more challenging.

Time-Consuming Data Collection and Analysis: Developing an accurate network analysis requires detailed data on task durations, dependencies, and resource availability. Gathering and analysing this information can be time-consuming, delaying the project's initiation.

Uncertainty and Dynamic Changes: Construction projects are prone to uncertainties such as weather disruptions, material shortages, or unforeseen design changes. These dynamic factors can render initial network analyses obsolete, requiring frequent updates and adjustments (Abdelalim, Salem, Salem, Al-Adwani & Tantawy, 2025).

Resource Allocation Issues: Although network analysis helps optimise resources, it may not always account for sudden resource shortages or overlapping demands. This can lead to inefficiencies, delays, or increased costs.

Limited Expertise Among Project Teams: Implementing network analysis requires specialised knowledge of project management tools and techniques, such as CPM, PERT, or DSM. A lack of expertise among team members can hinder its effective application (Mostafa, 2023).

Dependence on Accurate Estimations: Network analysis relies heavily on precise estimates for task durations and resource requirements. Inaccurate estimations can lead to flawed schedules, missed deadlines, and cost overruns.

Resistance to Change: Introducing network analysis in a building project may face resistance from stakeholders who are accustomed to traditional project management methods. This resistance can slow down adoption and limit its effectiveness (Pryke, 2024).

Software and Technological Limitations: While network analysis tools and software facilitate the process, they may require significant investment in terms of cost, training, and implementation. Moreover, technical issues or software incompatibility can impede smooth operation.

Difficulty in Managing Interdisciplinary Coordination: Building projects often involve multiple disciplines such as architecture, engineering, and construction. Coordinating these diverse teams within the framework of network analysis can be challenging, especially when there are conflicting priorities.

Overlooking Non-Quantifiable Factors: Network analysis primarily focuses on measurable parameters, potentially overlooking qualitative factors such as stakeholder relationships, communication barriers, or cultural differences, which can also impact project outcomes.

The Mitigating Strategies to the Challenges Encountered using Network Analysis for Building Project

Network analysis is a valuable tool for managing building projects, but it is not without challenges. To address these issues, project managers can adopt various strategies to ensure its effective implementation. Below are the mitigating strategies to the challenges encountered using network analysis for building projects:

Simplifying Complex Projects: For large-scale projects, breaking the project into smaller, manageable sub-projects simplifies the network analysis. Sub-networks can be developed for each segment, making it easier to track progress and manage dependencies (ClickUp, 2025).

Investing in Training and Capacity Building: Providing specialized training for project teams ensures they understand and can effectively apply network analysis tools like CPM, PERT, and DSM. Skilled personnel can handle complexities and adapt the analysis to changing project requirements.

Using Advanced Software Tools: Modern project management software offers real-time updates, automated calculations, and user-friendly interfaces. Tools like Microsoft Project, Primavera, or Asta Powerproject can simplify network analysis and improve accuracy.

Establishing Accurate Data Collection Methods: To mitigate issues related to inaccurate estimations, project managers should implement robust data collection techniques. Conducting detailed feasibility studies and using historical data can help improve task duration and resource allocation predictions.

Adopting Flexible and Adaptive Planning: Given the dynamic nature of construction projects, it is essential to adopt flexible planning approaches. Regularly updating the network diagram to reflect changes in scope, resources, or timelines ensures the analysis remains relevant.

Enhancing Resource Management: Implementing resource leveling and smoothing techniques can address resource allocation challenges. Maintaining a contingency reserve for unexpected resource demands further ensures that the project stays on track.

Fostering Interdisciplinary Coordination: Encouraging collaboration among different teams involved in the project—architects, engineers, and contractors—enhances communication and alignment. Regular meetings and integrated network diagrams can improve coordination and reduce conflicts.

Promoting Stakeholder Buy-In: Educating stakeholders on the benefits of network analysis can reduce resistance to its adoption. Involving them in the planning process fosters ownership and cooperation, facilitating smoother implementation.

Incorporating Risk Management: Developing a risk management framework within the network analysis allows for identifying and addressing potential delays or bottlenecks. Risk mitigation strategies, such as contingency planning, ensure project resilience against uncertainties.

Monitoring and Continuous Improvement: Regularly monitoring the network analysis for deviations and incorporating lessons learned into future projects enhances its effectiveness. Continuous improvement strategies ensure that challenges encountered in one project are avoided in subsequent ones.

Conclusion

The construction industry demands meticulous planning, efficient resource allocation, and timely execution for project success. Network analysis provides a powerful framework for optimizing schedules, managing dependencies, and mitigating risks. Its strategic tools, such as CPM and PERT, enhance decision-making, synchronize activities, and streamline workflows, ensuring operational efficiency and timely delivery. However, challenges such as technical expertise gaps and implementation costs persist. Addressing these barriers through training, technology adoption, and organizational support can unlock its full potential. Ultimately, network analysis is indispensable for driving innovation and resilience in building projects, making it a cornerstone of modern construction practices.

Recommendations

1. To maximise the benefits of network analysis in building projects, stakeholders should invest in training and capacity-building initiatives. Project managers, engineers, and other construction professionals should receive tailored training on tools like the Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT).
2. The integration of advanced technologies, such as project management software and artificial intelligence (AI), can enhance the accuracy and efficiency of network analysis.
3. The successful implementation of network analysis requires robust organisational support and clear policy frameworks. Companies should foster a culture of innovation by encouraging openness to change and addressing resistance through awareness programs.

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