International Journal of Scientific Research & Engineering Trends
Volume 9, Issue 5, Sep-Oct-2023, ISSN (Online): 2395-566X

Commercial and Technical Elements Evaluation of Highway Construction with Optimization Its Performance

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Abstract- The highwaynetworks were built to connect the rural people to the town area or to other destination required by the local residents. Normally the highwaywill be developed to connect or increase the socio-economic opportunity in rural area. The green road is one of the key areas that can be look into to create the sustainable concept based on three key aspects namely social, environmental and economic factors. The main focus of the commercial and technical elements evaluation of highway constructionis to increase the profits using more efficient resources, especially materials, improving the quality of life by meeting the national needs of social aspects and protecting the environment from the effects of CO^2 emissions and efficient use of natural resources for environmental aspects. Therefore, it is important that stakeholders include sustainability criteria in their projects. The application of a sustainable concept on the road can be assessed by the green road evaluation tool. Therefore, the main aim of this study is to build review of commercial and technical elements to evaluate and declare highway.

Keywords- highway projects; execution constraints; stakeholder management; construction projects.

I. INTRODUCTION

The economy of a country is largely influenced by its industrial and infrastructure development. The growth of a nation's industrial and infrastructural sectors has a significant impact on the economy of that country. Because highways serve as the arteries of national growth, highway development is one of the most essential contributors to infrastructure development. Highway development is one of the most important contributors to infrastructure development due to the fact that roads serve as the arteries of national growth and development. Distribution is crucial in the products production-distribution-consumption process. Greater per capita consumption cannot be guaranteed by increased output alone unless effective distribution is available. The process of product creation, distribution, and consumption is reliant on effective distribution. Increased production alone will not be sufficient to ensure higher per capita consumption unless and until effective distribution is provided. Roads and highways are the arteries of distribution, and efficient transportation is the key to effective distribution.

Transport infrastructure, such as roads and highways, is essential for successful distribution, and efficient transportation is critical to this. Road transportation is the only mode of transportation that can give optimum service to everybody and offers maximum flexibility to users among the numerous means of transportation now available. Road transportation is the only method of transportation that can provide the best possible service to everyone while also providing the most amount of freedom to customers among the different modes of transportation already accessible today. A well-designed road network not only serves as a feeder system for other forms of transportation, but also as a stand-alone route of transportation throughout the country. As a feeder system for other modes of transportation, a well designed road network also acts as a stand-alone mode of transit throughout the whole nation. The accessibility of many types of vehicles, the reduced cost of maintenance compared to other forms of transportation, and the simplicity of networking are all intrinsic properties of roads that promote efficient movement. Inherent characteristics of roads that support efficient travel include their accessibility to many different kinds of vehicles, their lower maintenance costs as compared to other modes of transportation, and the ease with which they may be linked together.

II.CONSTRUCTION SCHEDULING

Because of the need for effective coordination of men, material, and machines, highway construction is one of the most complex and difficult tasks among construction projects Highway building is one of the most complicated and challenging activities in the construction industry due to the need for excellent coordination of employees, materials, and machinery The uncertainty in the terrain, weather, and labor issues, among other things, contribute to the complexity. The duration of the activities linked

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with the project is the primary input in all scheduling systemsalmost all scheduling systems rely heavily on the duration of the activities associated with the project as their major inputThe user must submit this information.

III. TECHNICAL ELEMENTS AND COMMERCIAL ELEMENTS

In most cases, extensive surveys and subgrade planning precede highway construction. There are many aspects of highway design that can be broken down into technological and commercial components.

Technical Elements

- Elements of technology
- Material quality
- Installation techniques
- Traffic

Commercial Elements

- Environmental considerations in contracts
- Aspects of politics and law
- Concerns from the public

Regardless of the project type, highway construction usually starts at the lowest elevation of the site and progresses upward. By looking over the project's geotechnical requirements, we get an idea about the following:

- Current ground condition.
- Specific equipment requirement for excavation, grading, and material transportation to and from the site.
- Properties of material to be excavated.
- For below-grade work, dewatering requirement.
- Excavation safety criteria
- Quantities of water for dust control and compaction

Maintenance Of Highways

The ultimate goal of highway maintenance is to correct flaws and maintain the structure and usability of the pavement. In order to construct an adequate maintenance plan, defects must be identified, recognised, and registered. Flexible and rigid pavements have different defects.

The four primary goals of highway maintenance are as follows:

- Repairing functional pavement defects helps to prolong the pavement's functional and structural life.
- Ensure road protection and signage.
- Keep the highway in a usable state
- Highway systems and all of their components can be kept in initial, as-built condition by following routine maintenance procedures.
- Last, but not the least a bit about the safety.

Highway Engineering Safety

Highway engineering safety is important since it involves the life of people. Automated traffic signals can be used to further ensure this.

Highway under construction

- Safety management is a comprehensive approach to reducing the frequency and severity of traffic incidents.
- The key to improving highway safety is to design, develop, and maintain highway structures that are much more tolerant of the average range of man/machine interactions with highways.
- Over time, technological advances in highway engineering have enhanced the methods used in design, construction, and maintenance.

III. QUALITY ASSURANCE SPECIFICATIONS AND PRACTICES

Traditionally, contractors are responsible for their quality control, and state departments (DOTs) are responsible for acceptance and independent assurance. With changes in federal regulations, the roles of the two are somewhat unclear. Under the new rules, the contractor can perform their own quality tests. Issues may arise when this is the case. Many times, the DOT will perform a test and compare it to the contractors to determine if the results are within the acceptance limit. According to a study by Harrigan, many tests were ran and compared between the contractor's results and the state highway agency results. The results found that the contractor's quality tests were much stricter than that of the DOT.

While there is no real push to use contractor quality tests at this time, it may be an opportunity for DOTs to save time and money on the overall construction project (Harrigan, 2007). So, why do we need quality? Quality is a perceptual, conditional, and somewhat subjective attribute and may be understood differently by different people. We as consumers tend to focus on the quality of a product or service or how it compares to its competitor in the marketplace. In construction, we measure the conformance quality or degree to which the product or service was produced correctly. A quality item or product has the ability to perform satisfactorily in service and is suitable for its intended purpose.

Motivation

According to a Federal Highway Administration report (FHWA, 2010), the total vehicle miles traveled (VMT) on U.S. roadways increased from 1.5 trillion to 3.0 trillion from the 1980s to 2010s, while the total length of public roads only increased by about 5%. To keep up with the pace of the growing need to improve network performance, the investments in adding roadway network capacity and in maintaining and replacing existing infrastructure increased significantly. As a result, the number of construction projects has increased over the years.

In order to minimize the adverse traffic disruptions while preserving quality of work and fulfilling the budget of constraints, transportation departments and agencies across the country are dealing with bigger challenges created by these construction activities. Although there are

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various traffic analysis tools that can assist decision makers with a better understanding of highway construction projects, there is a need for an integrated process of decision making that utilizes the appropriate level of analysis to generate the parameters required for the decision problem at hand. The parameters required for the decision process includes, in addition to direct and indirect construction costs, road user costs, that will be an important focus of this dissertation. Direct construction costs include the material, labor, and equipment costs needed during construction. The indirect costs include preliminary engineering, right-of-way, construction engineering, and inspection costs.

IV. LITERATURE REVIEW

[1] Base Paper-Xiaochun Qin, Post-assessment of the eco-environmental impact of highway construction– A case study of Changbai Mountain Ring Road: The eco-environmental impact of highway construction is a long-term and cumulative process. Most of the existing studies pay attention to the environmental impact assessment technology of highway construction period and completion acceptance period, which can not fully explain the eco-environmental impact of highway operation period. At the same time, most of the previous studies have a single index and less consideration of the impact on species. Aiming at the highway located in the forest ecosystem in the middle temperate zone, considering the four aspects of species, land use, landscape pattern and ecological function, this paper establishes the post-evaluation index system of the eco-environmental impact of highway construction projects. This paper puts forward the quantitative assessment technology and spatio-temporal scale identification method of the long-term evolution of the impact of highway construction on the ecological environment, and uses the analytic hierarchy process to construct a comprehensive post-assessment system of ecological environmental impact of highway construction projects.

[2] Enlin Ma, Self-healing of microcapsule-based materials for highway construction: A review: Maintaining the health and reliability of civil facilities is of strategic importance. In highway engineering, pavement cracking impairs the road service and travel comfort level, while structure cracking can cause catastrophic damage. Microcapsule-based self-healing materials offer solutions to auto-recovery micro-cracks and maintain structural health. Such solution has become available by laboratory synthesis and proved effective in addressing the cracking problem during long-term mechanical, thermal, and hydraulic conditions. However, full-scale applications of this technique are not prevalent, showing its potential limitations in highway engineering.

[3] Aimin Sha, Highway constructions on the Qinghai-Tibet Plateau: Challenge, research and practice: Highway constructions on the Qinghai-Tibet Plateau (QTP) face great challenges induced by the unique local environmental, geological, and engineering conditions. The large area of permafrost, great temperature variability, strong UV rays, and complex geological conditions are the major factors that adversely influence the long-term performance of pavement systems. Since 1960s, Chinese engineers and researchers have started conducting research on the QTP to enhance the performance and durability of pavement systems. The present paper provide a comprehensive review of challenge, research and practice of highway constructions on the QTP including the special environmental and geological conditions, history of highway constructions on the QTP, major challenges and the state-of-the-art technology of subgrade constructions on permafrost, developments of the pavement structures and materials, performance prediction and maintenance methods of pavement surfaces, and applications of the research achievements on the first expressway on the QTP (i.e., Gongyu Expressway).

[4] Ting Shang , Opportunism or symbiosis? A case study on contractors' unsustainable highway construction in China: Highway construction generates considerable adverse effects on the natural environment, which has attracted closer attention from both government and the public. Although contractors are stimulated to engage in sustainable construction, contractors incline to select unsustainable practices. This research aims to investigate the reason why contractors adopt unsustainable practices. A semi-structured interview and content analysis were employed to explore environmental changes and contractors thought on making a decision. The research findings indicate that contractors use environmental restoration to escape environmental responsibility and government punishment. Governments have a tolerance for the environment which reduces environmental management. This study offers a new perspective to investigate contractors' unsustainable construction and provide clues to improve sustainable construction.

[5] Yan Gao , Low-construction-emission cross-section optimization for mountainous highway alignment designs: Designing low-construction-emission cross-sections of mountainous highway alignments is challenging. To address this issue, this paper develops a framework of cross-section optimization for highway alignment (COHA) to minimize the construction costs and emissions of the mountainous highway. First, COHA enumerates the earthwork costs of all possible highway cross-section locations in each cross-section profile. Second, we classify cross-sections into two categories, sensitive and nonsensitive cross-sections, with stochastic dominance (SD) theory and a complete ranking method. Third, to obtain the final optimized highway alignment, the initial alignment determined by optimal cross-sections is fitted by the weighted least square method with two dimensions. Finally, this methodology is applied to a real-

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world case study in a mountainous region, and the results verify that COHA can automatically optimize highway alignment, decreasing carbon dioxide emissions and land use by 3.6% and 3.1%, respectively, compared with manual work.

[6] Sheldon A. Blaauw, Exposure of construction workers to hazardous emissions in highway rehabilitation projects measured with low-cost sensors: Construction workers on highway rehabilitation projects can be exposed to a combination of traffic- and construction-related emissions. To assess the personal exposure a worker experiences, a portable battery-operated Air Quality Device (AQD) was utilised to measure emissions during normal construction operations of a major road rehabilitation project. Emissions measured were nitrogen dioxide (NO2), Total Volatile Organic Compounds (TVOCs) and Particulate Matter (PM10, PM2.5, and PM1). The objective of the paper is to document the hazardous emissions that construction workers may be exposed to and allow for a basis of informed decision making to mitigate the risks of a road construction project. Most critically, this article is designed to raise awareness of the potential impact to a worker's wellbeing as well as highlight the need for further research.

[7] Ping Zhou , Evaluation system of worker comfort for high geothermal tunnel during construction: A case study on the highway tunnel with the highest temperature in China: Geothermal environment is easily formed due to alternating uplift or subsidence of continental plates in the world. In this special environment, tunnel engineering activities will inevitably encounter the problems of high temperature and thermal damage. In the construction process of high geothermal tunnel, high temperature has a great impact on the comfort of workers. This paper is based on the extra-long highway tunnel with the highest temperature of 88.8 °C in China. Through literature research, field monitoring, numerical simulation, theoretical calculation and other means, this paper investigates evaluation system of worker comfort during construction in high geothermal and deep buried tunnel.

[8] Ahmed H. Ibrahim, Sustainability index for highway construction projects: The focus of this research is to develop a sustainability index for Egyptian highways construction projects that assist highways engineers, mangers and highways agencies to develop sustainable design, construction, operation and maintenance processes for highways. It acts as a sustainable measurement tool for highways construction and maintenance practices to determine the achieved performance of sustainability in the highways construction projects represented by an index. This index reflexes the implementation amount of sustainable choices used throw the highways construction process and even more in the maintenance process.

[9] A.P. Bazhanov, Development of a Methodology for Optimal Control of the Reliability of Highways at the Stages of Their Design and Stages of Construction, Reconstruction, Repair, and Maintenance: A methodological approach to the problem of research and selection of specific optimal procedures while ensuring indicators of the reliability of highways is stated, oriented in relation to both their temporal and spatial coordinates. In general, their mathematical models are presented in the form of continuous or discrete random processes. A specific methodological approach to the choice of rational intervals is proposed, based on statistical modeling of processes that affect the numerical values of the time variables of the defining parameters of highways using elements of the general correlation theory of random processes. The main calculation ratios are presented, which are necessary for the implementation of optimization procedures while ensuring the numerical values of the defining parameters of highways in their characteristic control points, which affect the reliability indicators of highways. A meaningful analysis of individual approaches to the choice of rational control intervals from the point of view of their practical use, in relation to the tasks of ensuring reliability indicators of highways at the stages of their design and stages of construction, reconstruction, repair, and maintenance is carried out.

[10] Alexis Pinsonnault-Skvarenina, Perception of noise mitigation approaches along a major highway construction site: The aim of this study was to describe the perception and satisfaction of mitigation measures along the construction site of a major urban highway, and to quantify the relationship between mitigation measures and noise annoyance. A total of 1,409 participants were included in a first socio-acoustic survey in 2018, and 609 in a second survey in 2020. Residents were generally satisfied with most of mitigation measures, although a reduction in their perceived effectiveness was observed in the 2020 survey. The perception of mitigation measures explained between 2.9 and 6.5% of the variance in construction noise annoyance. Traffic management, site surveillance and temporary noise barriers were the most important variables in the statistical models. While some measures are used only by a small proportion of the target population, our results show that implementing comprehensive mitigation measures can help to reduce construction noise annoyance.

V. RESEARCH HYPOTHESIS

- The impact of infrastructure construction on landscape patterns
- The impact of infrastructure construction on ecological risks

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- Research on landscape ecological risk assessment methods.

Evaluation of Highway Construction

Phase 1: Planning

The first step to road construction is planning. This is where you take a look at the current and future patterns of traffic in the area and study them. During the planning stage, you should also perform a cost-benefit study to see if the road you will build can fulfill its purpose.

The planning phase of road construction involves creating layout drawings, securing funding, taking care of legal aspects. You should also address any environmental issues while planning your road construction project. Taking care of these before starting the actual construction will help you avoid financial or legal problems in the future.

The process of deciding when to modify or build a section of road is often lengthy. Transportation planners identify and prioritize functional, structural, and safety issues regarding roads. If an issue is becoming problematic, alternatives to address it will be considered (FHWA 2005). The negative effects of transportation infrastructure and rights-of-way on communities and the environment are well documented. New road alignments or major road widenings are often controversial and often require extensive study of functional, cultural, environmental, and aesthetic issues.

The Federal Highway Administration (FHWA), several Departments of Transportation (DOT), and several States have adopted policies to provide sustainable highway design, Context Sensitive Solution studies, and incorporation of CSS solutions into their transportation projects. As examples, the policy framework to provide Sustainable and Context Sensitive Solutions is found in the governing policies and design procedures for both the Illinois Department of Transportation and the Indiana Department of Transportation.

In the State of Illinois Statute 605 ILCS 5/4-219 Context Sensitivity, the Illinois General Assembly intends to ensure that highway projects "meet the State's transportation needs, exist in harmony with their surroundings and add lasting value to the communities they serve." The design process is to include "early and on-going collaboration with affected citizens, elected officials, interest groups, and other stakeholders to ensure that the values and needs of the affected communities are identified and carefully considered in the development of transportation projects." Further, the CSS process and design "shall promote the exploration of innovative solutions, commensurate with the scope of each project that can effectively balance safety, mobility, community and environmental objectives in a manner that will enhance the relationship of the transportation facility with its setting" (State of Illinois General Assembly-a, 2013).

Similarly, the Indiana Department of Transportation has a written policy "to incorporate Context Sensitive Solutions (CSS) into the planning, development, construction and maintenance process for improvement to the state jurisdictional transportation system." The Indiana Procedural Manual for Preparing Environmental Documents 2008, (Indiana, 2008), includes section II.B.3.f Context Sensitive Solutions (CSS), that highlights that CSS seeks to benefit the community by:

- Incorporating feedback from the locals affected by the proposed project,
- Encouraging Collaboration Between Neighborhoods And Local, State And Federal Officials,
- Enhancing Roadway And Transit Communities,
- Considering Bicycle And Pedestrian Access Needs,
- Assisting The Development Of Strategies For Smart Growth And
- Encouraging Assessments And Design Of Alternatives Consistent With Local Needs.

While the CSS process works to identify both broad and detailed impacts of a project and proposes appropriate mitigation and enhancements, the process must also accomplish the prime goal of the project and be sustainable over the long term.

VI. CONCLUSIONS

Besides the previously mentioned oservations, there were certain additional limitations, and the first one is the limited availability of respondents. Another limitation was, as compared to building projects, literature in the case of highway projects is still emergent. Since the study followed an unsupervised learning approach and performance was an unobserved construct, a major limitation was predicting the relationship between the factors and performance. Since the scope of this study was to categorise the factors under groups, this limitation would be overcome in future studies by using structural equation modeling approaches. Therefore, it is recommended to develop an efficient project planning methodology which is a continuum of project management skills and tacit knowledge of managing site operation efficiently. Additionally, future research should explore the factors that can influence the proper record keeping of equipment maintenance. Also, research can be carried out to explore the measures by which to control heat exposure and burn injuries inflicted on the workers on-site.

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