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Research Paper

Route Survey and Feasibility Assessment for Over-Dimensional Cargo Transportation by Road

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ABSTRACT

Logistical and regulatory safety issues that result from the transport of over-dimensional cargo (ODC) impose significant difficulties due to unique characteristics associated with project cargo. The study assessed an entire route to evaluate if it could accommodate a 72 MT ODC shipment travelling from Siliguri to Sevoke via Melli to Rangpo as part of the PGCIL Rangpo Project. Conducting research using a case study methodology that used a field-based approach identified critical infrastructure barriers that would pose obstruction for transporting ODC via steel truss bridges, ghat sections, railway level crossings, narrow city streets, and access roads that are susceptible to landslide events. The project utilized the Critical Path Method (CPM) as a tool to schedule and analyze project activity to arrive at a minimum duration of 24 days. There were several steps that needed to occur before the project could be fulfilled, including the completion of route surveys, obtaining statutory approvals, developing site-access roads, conducting night-time movement of ODC, and completing the final placement operation of the ODC at its delivery location. A float analysis and correlation analysis produced the finding that the most significant risk is represented by regulatory approvals. The presence of hidden project risk includes the limited flexibility of schedule associated with near-critical-path project activities, where only one-day flexibility exists in the schedule. The study results suggest that the successful transport of ODC only results in mutually cooperative efforts between organizations involved in building the required infrastructure and coordinating the operations of all transportation modes.

Keywords: *Route Survey, Feasibility Assessment, Over-Dimensional Cargo, Transportation, Road*

Over dimensional freight transportation (ODC) transport deals with compliance & regulatory difficulties (logistically) due to the large weight and size of the load. The study uses 72 categories of ODC freight that cannot be shipped on any standard transportation mode (due to its size & dimension exceeding normal limits) — a width of 2.6 m or more; length of 48/53 ft. or more; height of 4.1/4.4 m or more; & weight of 80,000 lbs. or more. ODC loads require specialized vehicles that can transport them (such as Low-Bed Trailers, Extendable Trailers, Multi-Axle Hydraulic Modular Transporters, & Marine/Ro-Ro

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Systems for International Transport). Without viable networks of ODC transportation systems, the success of any major projects (e.g., Electrical Generation Plants, Highways, Bridges, Railroads & Renewable Energy Facilities) would not be possible. The CMVR (Central Motor Vehicles Rules) establish the regulatory framework for ODC transportation in India, while both national/state permitting systems enforce ODC operations; both operate according to the guidelines established by the Ministry of Road Transport & Highways.

Statement of the Problem

Logistics contractors do not follow a defined evaluation process to determine whether or not a route is feasible for transporting oversized dimensional cargo (ODC), which causes delays in the project and leads to increased costs and safety violations. The Siliguri – Rangpo corridor has critical limitations, namely: (a) ghat sections, (b) low bridged steel truss bridges and (c) a railway crossing that must be closed in order to get approval, as well as urban development restrictions and (d) a landslide-prone access road measuring three kilometers. As a result of these constraints, there is a need for a detailed constraint analysis and a reliable method to scientifically develop accurate project schedules to be used in evaluation of proposed ODC movement plans.

Need for the Study

The purpose of this study is to evaluate how infrastructure limits movement of ODC, such as having narrow roads with sharp curves and steep grades, weak bridges, low heights of structures, and utility crossings. The study will evaluate whether the existing roadway system will be able to support the movement of ODC without damaging the roadway and disrupting traffic. There will be road widening needed, utility lines will need to be blocked out, and structural reinforcement will be needed.

- This project must adhere to ALL regulatory and safety requirements that apply to NHAI, PWD and State Transport Authority.
- This project will pursue its operational risk reduction goals through organized scheduling of work using the Critical Path Method (CPM).
- The organization will establish standards for ODC route survey throughout India.

Objectives

The purpose of this project is to:
Conduct a route survey to cover 72 tonnes of out of gauge transport between Siliguri, Sevoke, Melli & Rangpo (the entire East-West corridor).

- Identify & assess infrastructure constraints (bridge capacity, turning circles, height restrictions & landslide/area). - Establish a critical path through the ODC project using CPM (Critical Path Method) and establish float periods for all activities.
- Complete an overall analysis & make recommendation for mitigation methods for ODC transport.

REVIEW OF LITERATURE

risk and requires a large initial investment in specialized handling equipment, trained personnel, and organized logistical planning. Slack and Gouvernal (2015) examined intermodal networks with respect to OC and reported that congestion and lack of available lift equipment are two major impediments to OC transportation efficiency. Janani and Anitha Kumari (2025) reviewed the OC transportation system in India and identified several reasons for delays, including limited route surveys, multiple required permits and ineffective coordination with local government agencies. Vasantha et al. (2024) identified multiple limiting factors affecting OC transportation in Africa, including loading restrictions on roads and bridges, many of which are restricted in width, and overhead utility placements. Singh et al. (2024) provided information on the ability of a location's roadway infrastructure to support the load imposed as a result of OC transportation. According to Sharma & Kumar (2020), Nair & Menon (2021) suggested that a feasibility study regarding oversized cargo should be conducted prior to moving it to reduce the level of risk, reduce accidents and ultimately minimize the possibility of a project delay in the early stages when conducting route reconnaissance. Nair & Menon (2021) proposed a "structured route survey framework" which would be used to manage the risk of bridge failure or traffic disruptions for large freight movement. Patil & Deshmukh (2022) conducted research on GIS and GPS based tools and their use in planning routes for freight; they found that digital mapping will improve the feasibility assessment process for Oversized Cargo (ODC). Mehta et al. (2023) discussed the planning of technology-based logistics solutions through digital mapping for route planning and forecasting risks associated with abnormal cargo movement. The report prepared by TERI (2024) supports the conclusion that the majority of the bridges & highways in India were not designed to carry abnormal loads. As a result, a route feasibility study and a structural assessment should be carried out concurrently with the structural design review. The Department for Promotion of Industry and Internal Trade (DPIIT) (2023-2024) has made significant enhancements to the use of digitised route planning & single-window approvals.

RESEARCH METHODOLOGY

Research Design:

This study uses a project case study approach for the collection of data from an “actual” ODC route survey on the Siliguri-Sevoke-Melli-Rangpo (the site of the PGCIL Project) corridor. This approach of collecting data will permit collection and evaluation of data through direct observation, on-ground measurement and contact with stakeholders for practically validated feasibility conclusions.

Sample:

The entire route length of 82 km (51 mi) is reflected by the surveyed lengths of 82 km (51 mi) using multiple survey points to measure all 7 major bridges, including 2 located at the Sevoke Railway Crossing (SK202), along with 3 additional stretches in urban town locations, approximately 3 km long each, that are subject to a potential future landslide-related access road, as well as multiple ghat sections along and adjacent to route.

Primary Data Collection:

Field Researchers recorded width of the roadway, height above the ground, pavement condition, curve radius, slope, dimensions of the toll plaza, distances from check points to center line of the roadway, and whether or not the area was prone to landslides. They incorporated into their research the use of laser distance meters, measuring sticks and poles, GPS, odometers and digital cameras for all measurements taken by the team. The testing process conducted on the roadway included evaluating maneuverability of a trailer around hairpin turns, evaluating load-carrying capacity of a bridge and evaluating stability of soil at locations where there was damage to a roadway.

Secondary Data:

The supporting data were collected from multiple sources which included Google Maps and IRC and NHAI guidelines and local PWD road reports and historical landslide zone records.

Analytical Tool — CPM:
The Critical Path Method (CPM) was executed using Activity-on-Node (AON) standards. The team performed forward pass and backward pass calculations to determine the Early Start (ES), Early Finish (EF), Late Start (LS), Late Finish (LF), Total Float (TF), Free Float (FF), Independent Float (IF), and Interfering Float (IntF) values for all ten of the project's activities.

ANALYSIS AND INTERPRETATION

1. Route Survey Findings

The survey found out about the critical issues with infrastructure functioning along the Siliguri to Rangpo corridor, which have led to the network of voices.:

Table 1: Major Infrastructure Constraints

Location / Feature	Key Measurement	Required Action
Sevoke Railway Crossing (SK202)	Bridge girder heights:4.75m & 4.9m	Railway shutdown required
Sweti River – Steel Truss Bridge	Truss height: 4.8m; Width: 7.6m	A must to complete
Geli Khola – Steel Truss Bridge	pan length of 60m; truss height 4.8;	Load tests, a must to complete
Melli Underpass	5.1m height clearance	pass conditionally
Rangpo River Bridge	5 spans x 60m; girder height 2m	Summer structural assessments are needed
Mining Bridge (Cantilever)	span length - 90 metres and 50 meters; solid girder arch	Engineering assessment will occur
Site Access Road (3 km)	not controlled by the Landslide	no pavement; construct road
NH10 Hairpin Bend	sharp curve/hairpin and nearby canal Bridge	Provides trial escort to end/final.

According to data collected during the previous survey, there is no absolute physical restriction on moving the aforementioned ODC. To begin the movement of the ODC, it is necessary to complete seven bridge load tests as well as obtain authorization for a railway crossing shutdown, and construct a third of a mile of access road in advance of cargo delivery.

2. CPM Network Analysis

Ten important things were identified then organized using the Activity on Node (AON) convention or method. The flow chart consists of 3 types of streams that all came from Activity A (route survey completion) which include a regulatory stream (A→B→E and B→F), an infrastructure stream (A→C→G and C→F) and an approvals stream (A→D→H). All of these streams combine together into Activity I (night movement) before going on to become Activity J (final placement).

Table 2: Activity List and Network Parameters

Act.	Name Activity Description	Duration (Days)	Early Start	Early Finish	Predecessor Activity(s)
A	Complete final routing survey	3	0	3	—
B	Accepted routing for approval from NHAI; PWD state bridge engineers	7	3	10	A
C	Load testing the truss bridges after construction	5	3	8	A
D	Obtain railroad shutdown approval before moving any truss bridges into place	4	3	7	A
E	Build site access road to truss bridge construction sites	6	10	16	B
F	Relocate existing overhead and underground electrical utilities	5	10	15	B, C
G	Move equipment to truss bridge installation sites	4	8	12	C
H	Conduct trial runs and check turning radii of trucks moving loaded truss bridge	3	12	15	D, G
I	Conduct night movements of loaded trucks through towns and ghat sections of road from site access to placement location	6	16	22	E, F, H
J	Final placement of loaded truss bridge at Rangpo	2	22	24	I

3. Comprehensive Activity Schedule with Float Analysis

Table 3: CPM Comprehensive Schedule and Float Analysis

Act.	ES	EF	LS	LF	TF	FF	IF	IntF	Status
A	0	3	0	3	0	0	0	0	**CRITICAL**
B	3	10	3	10	0	0	0	0	**CRITICAL**
C	3	8	4	9	1	0	0	1	Non-Critical
D	3	7	9	13	6	5	5	1	Non-Critical
E	10	16	10	16	0	0	0	0	**CRITICAL**
F	10	15	11	16	1	1	1	0	Non-Critical
G	8	12	9	13	1	0	0	1	Non-Critical
H	12	15	13	16	1	1	0	0	Non-Critical
I	16	22	16	22	0	0	0	0	**CRITICAL**
J	22	24	22	24	0	0	0	0	**CRITICAL**

The Critical Path consists of: A → B → E → I → J, which has a total duration of 24 days. The critical activities are in a different colour and are called near-critical. The remaining activities, C, F, G, and H are also considered to be near-critical, as they have only a total float of 1 day each.

Findings

The route survey and analyses of Critical Path Method (CPM) resulted in a number of key findings, which are as follows:

- The Siliguri-Rangpo ODC (over dimensional cargo) movement is technically feasible; however, it is conditional upon the advance preparation of route modification, infrastructure modification, and coordinated approvals by the multi-agency process.

- Seven significant bridges will need to undergo formal load testing and structural verification. Of note are the two steel truss bridges (Sweti River and Geli Khola), which present the most restrictive overhead vertically at a vertical truss height of 4.8 m.
- The Sevoke Railway Crossing (SK202) will require a formal railway shutdown approval to process. The total float for this activity is six days; however, the activity will need to be initiated early due to time constraints related to procedures.
- The site access road which runs 3 km in a landslide-prone area must be fully developed prior to the transportation of cargo and the completion of this activity is on the critical path with zero float.
- The CPM analysis establishes a minimum duration for this project of twenty-four days. Furthermore, five activities represent the critical path (A-B-E-I-J) with no flexibility in scheduling.
- Obtaining Statutory Permissions from the NHAI, PWD and Bridge Authorities (Activity B; 7 days; zero float) represents the highest individual risk activity on the schedule.
- Activities C, F, G and H have a one-day float and as such are near critical. Cumulative minor delays in these near-critical activities can create physical congestion at the merge point prior to transportation during the night period
- According to the initial estimates from the first few stages of the Plan for Logistics Reconfiguration, moving by way of the night through towns and ghat sections (Activity I, 6 days -- no float time) will be the most operationally complex phase of the project; it will require police escorts, pre-approved routes, and will need to have no tolerance for mechanical errors.
- The project is front loaded; Activities I & II will consume over 80% of the project's total duration [time], while the actual transfer of goods will consume only 8 days (Activities I + II).

Suggestions

- The findings yield several recommendations, as follows: - Prior to finalizing the route survey, obtain regulatory approval and engage with stakeholders to expedite the Activity B approval process (i.e. NHAI/PWD permissions).
- Create a dedicated permit coordination group to work with bridge authorities and NHAI, PWD and railway authorities to facilitate sequentially completed approvals in order to eliminate approval delays.
- Following mobilization and because of its importance (i.e. near critical to the project with one day of float), conduct bridge load testing (with Activity C).
- Next to obtaining permission, the first field activity after mobilization of the site access road development (Activity E), will be the first field activity that lies on the critical path, with no float.
- Maintain monitoring discipline for non-critical path activities (i.e. near-critical path activities C-F-G-H) similar to critical path activities to prevent float loss and cascading delays.
- Improve the accuracy and repetitiveness of route surveys through digital documentation including: GPS tagged photos, GIS mapping, and standard measurement templates.
- Create a 24-hour control facility during the night movement phase (Activity I) by integrating police escorts, on-site supervisors, equipment operators on-site and utility companies.
- Develop a standardized ODC route survey framework for hilly and eastern Himalayan corridors to facilitate future projects of similar nature.

- Engage with local communities and municipal bodies early to plan traffic diversions and minimize disruption during urban passage sections.

CONCLUSION

The report evaluated the entire route assessment and viability of transporting a 72 MT Over Dimensional Cargo (ODC) shipment along the Siliguri-Sevoke-Melli-Rangpo route for the PGCIL Rangpo Project—a difficult logistical task which requires not only careful coordination between all necessary parties, modifications to existing infrastructure, and an understanding of how long it will take to move cargo in that area of Northwest India—but also that ODC transportation in this part of the world is both extremely complex engineering-based operation that is highly dependent on accurate and timely project planning, detailed route planning calendering marketing calendars, and cooperation between multiple agencies throughout the complete ODC transporting process. The Project Critical Path Method (CPM) analysis determined a minimum project duration to be 24 calendar days which includes the completion of each step along the ODC route, with the level of complexity between activities projected to be substantial. The critical path activities included identifying the appropriate ODC route; obtaining all required governmental and legal requirements prior to conducting transportation along that route; obtaining access to/from all activity along the route where an ODC will be delivered; transporting the ODC between each of the major urban centres located along the ODC route after dark so that no additional incursion would take place outside of normal public road use from the beginning of night fall to when ODCs finish delivery within those urban environments; and finally, successful ODC delivery.

After conducting this study, we have come to the conclusion that the proposed ODC Movements can be implemented as has been planned, given that identified infrastructure-related obstacles/constraints are successfully addressed. Additionally, ongoing proactive efforts should be taken to ensure that the timely provision of regulatory approvals prior to beginning the movement of ODC will remain in tact.

Successful movement of ODC Shipments is primarily dependent upon making the necessary decisions and taking action in a timely manner to address these issues before beginning the movement of ODCs at either their discharge point or in-transit. The existence of a regulatory approval process was found to be the most substantial risk to successful ODC shipments' logistics and to have the greatest impact on overall shipment logistics.

Further, activities identified as having a critical and near-critical path will all have systemic risks associated with them regardless of whether they are considered critical or near-critical. In order to mitigate these risks, all activities along the shipment process will require the same diligence and consideration as will the identified critical path activities.

The best practices for the management of OD/ODC transport can be demonstrated by the collective combination of engineering-led project logistics; regional field surveys; comprehensive technical analyses; and stakeholder engagement/co-ordination. It is anticipated that the findings from this study will provide a mechanism for organisations developing their standard route survey methodologies within India. As such the study also serves as a reference for logistics planners, project managers, and policy makers involved in heavy-lift/project cargo operations within the country of India.

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Conflict of Interest

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