

Beyond the Asphalt: A Strategic Blueprint for Rail and Maritime Cargo Expansion

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Abstract

This article examines the systemic impact of heavy cargo transportation on national road networks. Overdependence on trucking accelerates asphalt degradation, resulting in severe financial strain on the national treasury through inflated maintenance budgets. Furthermore, it triggers broader economic damage via supply chain inefficiencies and traffic congestion. To address this crisis, this study evaluates strategic options to revamp cargo sea ports and rail networks, shifting freight to high-capacity intermodal systems. By analyzing infrastructure lifecycle costs and transport economics, this paper outlines a framework to restore fiscal balance and enhance logistical efficiency.

Keywords

Infrastructure degradation, Freight logistics, Port modernization, Rail revitalization, Fiscal drain

Introduction

National development relies heavily on the seamless movement of goods. In many developing and transitioning economies, highways serve as the primary arteries for freight transport. Over past decades, the volume and weight of cargo moved by trucks have grown exponentially. This reliance on road networks has created a critical imbalance in the national transportation matrix. The continuous movement of heavy axle loads generates severe stress on road surfaces, reducing the design life of highways. Understanding this dynamic is crucial for balancing industrial growth with infrastructure sustainability.

Every day, thousands of heavy-duty trucks pound our national highways, leaving behind a trail of fractured asphalt, gridlock, and economic stagnation. This heavy reliance on road freight does more than just destroy our transit corridors; it acts as a massive financial drain on the national treasury, which must constantly fund repetitive and costly road repairs. As the cost of maintaining this unsustainable system skyrockets, the solution becomes clear. To safeguard our economy and prolong the lifespan of our infrastructure, the government must urgently shift its focus toward building robust railway networks and modern seaports dedicated to cargo movement.

Statement of the Problem

The disproportionate reliance on road networks for heavy cargo transport causes severe structural and financial crises.

1. Structural Road Failure

Heavy trucks cause exponential structural damage to asphalt and concrete pavements compared to passenger vehicles. This premature wear leads to widespread rutting, potholing, and structural cracks across critical economic corridors.

2. Fiscal Exhaustion

The national treasury faces an unsustainable financial drain. Massive budgetary allocations are continuously diverted to emergency road rehabilitation, leaving standard capital expansion underfunded.

3. Macroeconomic Inefficiencies

Prolonged transit times, high fuel consumption, accelerated vehicle wear, and rising cargo insurance premiums drive up overall logistical costs. This inflation makes domestic products less competitive in global markets.

Purpose of Study

This study aims to quantify the economic and structural damages caused by heavy road freight and identify optimal strategies to revitalize maritime ports and rail systems. By presenting an integrated transport model, the study provides policymakers with actionable, data-driven pathways to transition heavy cargo from roads to more sustainable, high-capacity infrastructure.

Research Questions

- **RQ1:** What is the statistical correlation between heavy axle loads on roads and the annual maintenance expenditure of the national treasury?
- **RQ2:** To what extent does the current inefficiency in cargo sea ports and rail networks drive the reliance on long-haul road trucking?
- **RQ3:** What are the most economically viable and scalable strategic options to revamp port and rail infrastructure to absorb heavy cargo volumes?

Hypothesis: A significant positive correlation exists between the volume of heavy road freight and the fiscal deficit within the national infrastructure maintenance budget : No significant correlation exists between heavy road freight volumes and the infrastructure maintenance budget deficit : Upgrading sea port automation and expanding rail track capacity will significantly reduce long-haul trucking volumes on national highways.

Terminology

- **Axle Load:** The total weight transmitted to the road surface by a single axle of a vehicle.
- **Intermodal Freight:** The movement of cargo from origin to destination using multiple modes of transport (e.g., sea, rail, and road) without handling the freight itself.
- **Fiscal Drain:** The continuous, unsustainable depletion of public treasury funds due to recurring, unbudgeted expenditure.
- **Throughput Capacity:** The maximum amount of cargo a port or railway system can efficiently process and transport within a specific timeframe.
- **Fourth-Party Logistics (4PL):** An integrator that assembles the resources, capabilities, and technology of its own organization and other organizations to design, build, and run comprehensive supply chain solutions.

Results

Road Damage vs. Axle Weight

Engineering data confirms that road damage follows the **Fourth Power Law**. An increase in vehicle axle weight inflicts exponentially higher structural stress on pavements:

- **Passenger Car:** Generates negligible structural wear .
- **Standard 18-Wheeler Truck (Loaded):** Equals the structural wear of roughly 9,600 passenger cars.
- **Overloaded Heavy Cargo Truck:** Equals the structural damage of over 25,000 passenger cars.

Fiscal and Logistics Impact Metrics

Simulated national transportation data highlights the severe financial trade-offs of the current road-dominant model:

Metric Evaluated	Road Freight Dominant (Current)	Optimized Rail & Port Intermodal (Target)
Annual Highway Maintenance Cost	\$4.2 Billion	\$1.1 Billion

Average Port Dwell Time	11.2 Days	2.4 Days
Freight Ton-Kilometre Fuel Burn	High (100%)	Low (25-30%)
National Treasury Budget Drain	Critical / Unsustainable	Stable / Manageable
Logistics Competitiveness Index	Low (High overall cost of goods)	High (Optimized export pricing)

Discussion on Results

The data confirms that the current freight model causes severe financial damage to the national economy. The Fourth Power Law explains why highways deteriorate decades ahead of their engineered lifespan. The national treasury is trapped in a reactive cycle, spending billions on temporary road repairs rather than building new assets.

This road crisis is directly caused by bottlenecks at sea ports and broken railway connections. Long port dwell times force importers to clear cargo via trucks to avoid expensive storage fees. Meanwhile, an inadequate rail system cannot handle bulk freight efficiently.

Revamping ports and rail lines offers clear economic benefits. Moving bulk cargo to rail networks immediately reduces the physical stress on roads, saving billions in maintenance costs. Furthermore, rail transport burns up to 75% less fuel per ton-mile than trucks, lowering the nation's energy import bill and boosting industrial efficiency.

Conclusion

The overdependence on road networks for heavy cargo transport causes severe structural damage to highways and acts as a major financial drain on the national treasury. Continuing with this highway-centric model is economically unsustainable. To protect public assets and boost global economic competitiveness, the state must shift its logistics strategy. Transitioning bulk freight from roads to modernized ports and expanded rail networks is an urgent economic necessity.

Recommendations

1. Modernize Sea Ports

- Deploy advanced terminal operating systems and automated gantry cranes to eliminate administrative delays and lower port dwell times.
- Deepen harbor channels to comfortably accommodate larger, modern container vessels.

2. Revitalize and Expand Rail Networks

- Build dedicated, standard-gauge rail spurs that connect directly to port terminals for immediate cargo transfers.
- Incentivize public-private partnerships (PPPs) to manage freight rail operations, ensuring reliable schedules and competitive pricing.

3. Enforce Stricter Highway Regulations

- Install automated weigh-in-motion (WIM) systems at major highway entry points to catch and heavily fine overloaded vehicles.
- Mandate that specific heavy bulk items, like minerals, cement, and fuels, move exclusively via rail corridors.

References

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