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A Scenario-Based Assessment of Rail-Oriented Spatial Development in the Urmia–Serow Border Corridor, North-West Iran

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ABSTRACT

The Urmia–Serow corridor is a strategic border route in northwestern Iran facing road-based transport pressure, land-use transformation, and regional connectivity challenges. This study assesses the potential role of rail-oriented planning in supporting more coordinated spatial development along this corridor. The research uses a descriptive-analytical and scenario-based approach based on documentary sources, available transport records, field observations, visual interpretation of aerial and satellite images, and illustrative road-based fuel and energy scenario calculations. Existing road-oriented conditions are compared with a proposed rail-oriented planning scenario. The findings indicate that the corridor is affected by road dependence, land-use conversion pressure, and limited spatial coordination. A rail-oriented scenario may support better land-use organization, could help reduce part of the reliance on road-based movement under modal-shift assumptions, and support regional and cross-border connectivity, depending on demand, feasibility, and institutional coordination. Rail-oriented planning is presented as a potential planning strategy, not a confirmed causal solution. Further feasibility studies, updated official data, environmental assessment, and cross-border coordination are required before implementation.

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INTRODUCTION

Transport infrastructure is closely associated with regional accessibility, land-use patterns, and the spatial distribution of population and economic activity, although these relationships are context-dependent rather than automatic (Kotavaara et al., 2011; Rosik and Wójcik, 2023; Wang et al., 2021). In this context, rail-oriented spatial development can be understood as a planning approach that seeks to coordinate rail infrastructure with land-use organization and development around transport nodes (Maulat and Krauss, 2014; Wang et al., 2021). Previous studies have shown that rail accessibility and network configuration can be associated with population distribution and the spatial form of urban and regional development (Kotavaara et al., 2011; Alvarez et al., 2013; Kheyroddin and Ghaderi, 2023). However, the planning effects of rail infrastructure are not automatic; they depend on demand, land-use control, investment capacity, institutional coordination, and integration with broader regional development policies. Although rail-related spatial development has been examined in metropolitan regions and major transport networks, less attention has been given to peripheral border corridors where transport infrastructure, land-use management, environmental pressure, and cross-border connectivity intersect. This gap is important for the Urmia–Serow corridor in West Azerbaijan Province, which connects Urmia to Serow near the Iran–Turkey border. The corridor has strategic importance for regional movement and border-related activity, while also facing road-based transport pressure, scattered land-use transformation, agricultural land conversion, and environmental and safety concerns.

Accordingly, this study assesses the potential role of a proposed rail-oriented planning scenario in supporting more coordinated spatial development along the Urmia–Serow corridor. The analysis focuses on four interrelated dimensions: transport pressure, land-use organization, environmental considerations, and regional/cross-border connectivity. The study presents rail-oriented planning as a conditional planning strategy rather than a guaranteed solution to the corridor's development challenges.

LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

The literature on transport infrastructure and regional development generally shows that transport investment can influence accessibility, land-use patterns, economic interaction, and the spatial organization of regions. However, this relationship is not linear or automatic; it depends on institutional capacity, land-use regulation, economic demand, and the integration of infrastructure planning with broader regional development policies (Baum-Snow, 2007; Kotavaara et al., 2011; Rosik and Wójcik, 2023). Therefore, rail infrastructure should not be interpreted only as a physical project, but also as a planning instrument that can shape how settlements, activities, and mobility flows are organized. A second group of studies focuses on the relationship between rail systems and land-use change. These studies emphasize that rail corridors and stations may influence the concentration of activities, accessibility to development nodes, and coordination between transport and land-use planning (Maulat and Krauss, 2014; Wang et al., 2021). In this view, rail-oriented development is closely related to transit-oriented planning, but it is not limited to dense metropolitan areas. At the regional scale, rail-oriented planning can also be used to guide development along corridors, reduce scattered growth, and support more structured spatial organization, provided that land-use control and institutional coordination are present.

A third strand of literature addresses the environmental implications of alternative transport systems. Comparative environmental performance should be assessed on a life-cycle basis because vehicle operation alone does not capture the effects of infrastructure provision, fuel production, and supply chains, and differences in occupancy can alter the relative performance of transport modes (Chester and Horvath, 2009). Accordingly, any environmental advantage of rail in the present scenario should be treated as conditional on modal-shift potential, route demand, service frequency, technology, and implementation conditions. This is particularly important in scenario-based studies, where future environmental benefits should be presented as conditional outcomes rather than confirmed impacts.

Border regions introduce additional planning complexity because border functions, informal economic activity, governance conditions, and regional flows can influence spatial development (Kheyroddin and Rezapour, 2016; Rezapour et al., 2018). In the Urmia–Serow context, rail-oriented development also requires attention to regional and cross-border coordination (Kheyroddin and Jamshidi Farkhondeh, 2024). In peripheral regions, these issues are especially important because transport infrastructure is often expected to address multiple objectives at once, including accessibility, land-use organization, regional integration, and local economic development. In the Iranian planning context, several studies have also examined the relationship between transport infrastructure, spatial organization, informal development, and regional imbalance. Kheyroddin and Rezapour (2016) and Rezapour et al. (2018) highlight the importance of border-region dynamics, informal economic activity, and spatial change in peripheral areas. Kheyroddin and Naderi (2016) emphasize the role of transportation–land-use mismatch in producing scattered and unbalanced spatial development. Earlier Iranian studies have also addressed rail-corridor development in metropolitan areas (Kheyroddin and Piroozi, 2013), while subsequent research has examined rail-based spatial frameworks for controlling unbalanced metropolitan sprawl (Kheyroddin and Haghpannah, 2021). In the Iranian context, several studies illustrate spatial-development issues relevant to rail-oriented planning. Kheyroddin et al. (2017) document dispersed second-home development in the Tehran metropolitan region, illustrating a form of fragmented spatial growth associated with inadequate territorial planning. Comparable patterns of dispersed metropolitan growth have also been documented in Shiraz, where remote-sensing imagery and landscape metrics identified substantial horizontal expansion and urban sprawl during 1986–2014 (Azhdari et al., 2018). Kheyroddin and Abbaspour Kalmarzi (2019) propose a rail-based ecological tourism development model in which selected railway stations can function as focal points for tourism development and the organization of surrounding areas. Kheyroddin et al. (2020) further examine the relationship between historical railway infrastructure, mountainous settlements, and ecotourism development along the Tehran–Mazandaran railway. More directly, Kheyroddin and Ghaderi (2023) show that railway-network configuration is associated with the form and direction of metropolitan expansion. Recent work on the Tehran–Mashhad railway corridor further draws attention to landscape continuity and the need to integrate landscape considerations into rail-corridor planning (Kheyroddin et al., 2026). Together, these studies indicate that rail infrastructure should be considered not only as a transport facility but also in relation to land-use structure, landscape, and spatial development. In addition, Imani Shamloo et al. (2023) provide a relevant perspective on spatial justice and urban development assessment in the Iranian context, while Kheyroddin and Jamshidi Farkhondeh (2024) directly address rail-based development along the Urmia–Serow axis and therefore support the contextual positioning of the present study.

Based on this literature, the conceptual framework of this study considers the proposed Urmia–Serow rail-oriented scenario through four interrelated dimensions: transport pressure, land-use organization, environmental considerations, and regional/cross-border connectivity.

The study therefore positions the Urmia–Serow corridor as a peripheral border corridor where rail-oriented spatial development should be evaluated cautiously as a planning strategy, rather than as a guaranteed solution to transport, environmental, or regional development problems.

MATERIALS AND METHODS

This study uses a descriptive-analytical and scenario-based planning approach to assess the potential role of a rail-oriented development scenario in the Urmia–Serow border corridor. The methodology does not aim to provide a predictive transport model or a confirmed causal impact evaluation. Instead, it compares existing road-oriented conditions with a proposed rail-oriented planning scenario using documentary evidence, available transport records, traffic-count data, field observations of road-condition and roadside-safety issues, illustrative road-based fuel-use calculations, and visual interpretation of spatial changes.

The study area is the Urmia–Serow corridor in West Azerbaijan Province, Iran. The corridor connects Urmia to Serow near the Iran–Turkey border and functions as an important regional and border-related transport axis. The research process was mainly conducted during 2023-2024. However, because different types of evidence were obtained from different official and documentary sources, the time period of the data is not identical for all indicators. Road terminal passenger and freight data refer mainly to 2020-2021, traffic-count information refers to available 24-hour road survey data from March-April 2021, field observations were conducted during 2023-2024, and visual interpretation of land-use change was based on available aerial and satellite images covering the 2006-2023 period.

The research was conducted through four main steps. First, academic literature, planning documents, official reports, and technical sources were reviewed to define the conceptual background of rail-oriented spatial development and to identify the main planning issues of the corridor. Second, field observations and document analysis were used to describe the existing physical, transport, and land-use conditions of the corridor. Third, aerial and satellite images from Google Earth and Google Maps were visually interpreted to identify major patterns of land-use transformation, road-based development pressure, agricultural land conversion, and spatial concentration along the corridor. Adobe Photoshop was used only for map preparation, visual annotation, and figure presentation; it was not used as an analytical modeling tool. Fourth, the existing road-oriented condition was compared with a proposed rail-oriented planning scenario.

This comparison was based on selected planning indicators, including transport pressure, land-use organization, road safety concerns, fuel and energy implications, environmental considerations, and regional/cross-border connectivity. The scenario assessment is therefore exploratory and planning-oriented. It should be interpreted as an assessment of potential planning effects rather than as a statistically validated prediction of exact accident reduction, fuel saving, land preservation, or trade growth. The main limitation of the method is that the study relies on available secondary data and visual interpretation rather than on a full transport-demand model, detailed GIS classification, econometric estimation, or engineering feasibility simulation. Therefore, the results are presented cautiously as conditional planning implications. Further feasibility studies, updated official datasets, detailed environmental assessment, and quantitative transport modeling are required before any implementation decision.

STUDY AREA AND CORRIDOR CONTEXT

The study area is the Urmia–Serow corridor in West Azerbaijan Province, northwestern Iran. The corridor connects Urmia, the provincial capital, to Serow near the Iran–Turkey border. This location gives the corridor regional significance because it supports passenger movement, road-based trade, tourism-related trips, and access to the Serow border terminal.

Urmia is one of the main urban, administrative, and economic centers of West Azerbaijan

Province. Serow is a border city located approximately 55 km from Urmia and has local and regional importance because of its proximity to Turkey, border-market activities, customs-related functions, and tourism potential. The spatial relationship between Urmia and Serow makes the corridor relevant not only as a transport route, but also as a planning corridor where land-use organization, road-based transport pressure, environmental concerns, and border connectivity intersect.

The existing corridor is mainly road-oriented. It is one of the important transport axes connecting Urmia to the western border area and supports daily passenger movement, freight movement, and tourism-related trips. However, road-based mobility along the corridor is also associated with traffic concentration, safety concerns, fuel consumption, and pressure on surrounding agricultural and environmentally sensitive lands. These conditions provide the basis for assessing a proposed rail-oriented planning scenario.

Fig. 1 and Fig. 2 show the locations of Urmia and Serow within West Azerbaijan Province. Fig. 3 presents the Urmia–Serow corridor and its relationship with existing road and railway connections. Fig. 4 illustrates the spatial sequence of residential and development zones along the corridor. These figures are used to describe the study area and support the spatial interpretation of corridor conditions; they are not presented as outputs of a predictive GIS model. (Fig. 1-4)

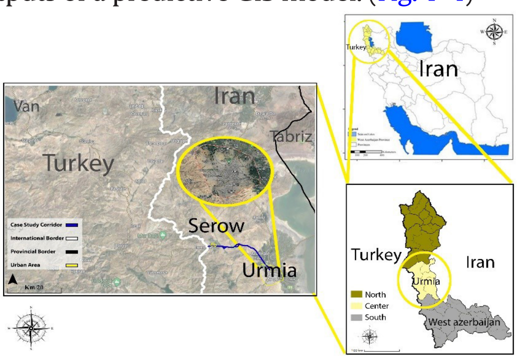

Figure 1: Location of Urmia city in West Azerbaijan Province, Iran, showing its regional position in relation to the Urmia–Serow corridor and the Iran–Turkey border area. (Source: Author)

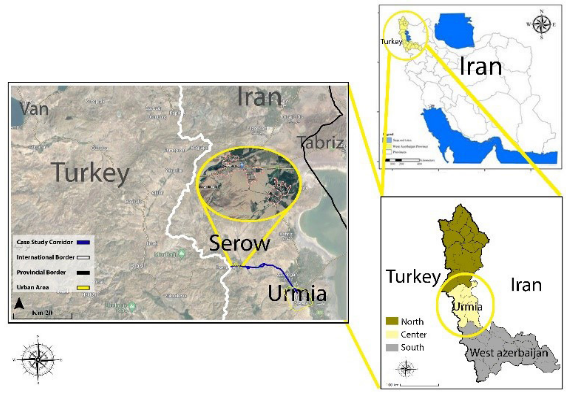

Figure 2: Location of Serow border city in West Azerbaijan Province, Iran, showing its proximity to Urmia and its spatial relationship with the Iran–Turkey border. (Source: Author)

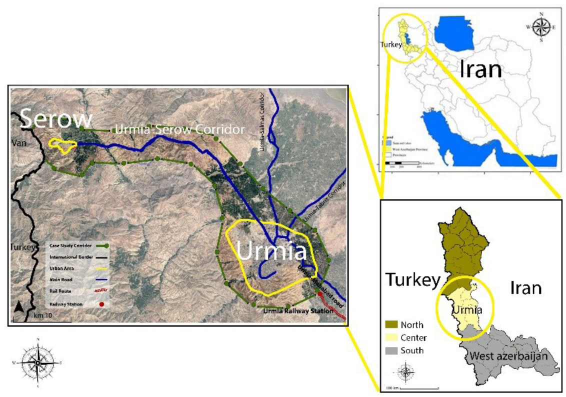

Figure 3: Urmia–Serow corridor showing the main road axis and existing railway connections used for spatial interpretation of corridor accessibility and regional connectivity. (Source: Author)

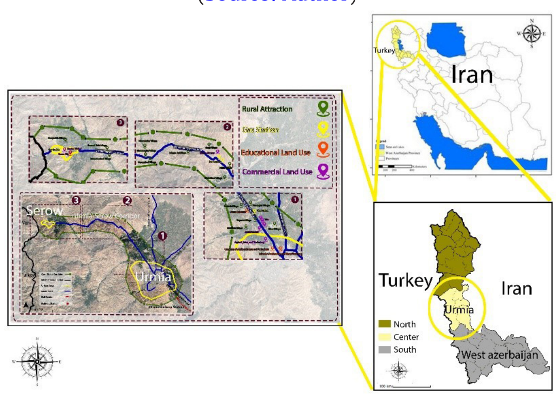

Figure 4: Residential zoning sequence along the Urmia–Serow corridor, illustrating the spatial distribution of settlement and development zones used to interpret corridor-based land-use organization. (Source: Author)

FINDINGS AND DISCUSSION

The results are presented as a scenario-based planning assessment of the Urmia–Serow corridor. The analysis does not claim to predict the exact impacts of rail development on accident reduction, fuel saving, or economic growth. Instead, it uses available transport records, traffic-count data, field observations, and spatial interpretation to identify existing corridor pressures and to discuss the potential planning implications of a rail-oriented development scenario.

1-Road-Traffic Conditions along the Urmia–Serow corridor

The road-traffic analysis was conducted to describe the existing road-oriented condition of the corridor and to identify the transport pressure that supports the need for alternative planning scenarios. The available road-terminal records for 2020–2021 indicate that Urmia had the highest number of reported intra-provincial trips and passengers among the listed counties, with 73,000 trips and 410,000 passengers. This result confirms the regional transport role of Urmia within West Azerbaijan Province, but it should not be interpreted as direct evidence that rail development would automatically increase international capacity or improve operational efficiency.

Table 1 presents the available passenger and freight records for selected counties associated with the broader transport area of the Urmia–Serow corridor. The table is used to describe the existing transport demand context and to compare the relative position of Urmia with other counties. It does not provide a predictive model of future rail demand. (Tab. 1)

Table 1: Intra-provincial trips, passengers, and freight volumes for selected counties associated with the Urmia–Serow corridor, based on available road-terminal and waybill records for 2020–2021. (Source: Author, based on road-terminal data).

County	Trips	Passengers Transported	Freight tonnage transported by public vehicles based on issued waybills (Tons)
Urmia	73,000	410,000	671,682
Salmas	5,000	10,000	71,705
Khoy	21,000	116,000	723,366
Poldasht	4,000	3,000	648
Showt	5,000	24,000	43,261
Maku	12,000	24,000	267,026
Chaypareh	3,000	14,000	64,474

The available 24-hour traffic-count data for the Urmia–Serow corridor refer to March–April 2021. These data show daily traffic variation along the corridor, with recorded traffic volumes ranging from 7,127 to approximately 14,000 vehicles during the observed survey days. The recorded average speed of 79 km/h and the concentration of traffic during peak periods indicate that the corridor functions as an active regional road axis. However, because the available data are limited to selected survey days, the results should be interpreted as descriptive evidence of corridor pressure rather than as a complete annual traffic model.

Overall, the traffic data suggest that the Urmia–Serow corridor already supports important passenger and freight movement. This condition provides a planning basis for assessing whether a rail-oriented scenario could help organize movement, reduce road dependence, and support more coordinated spatial development.

Further transport-demand modeling would be required to estimate exact future passenger shifts, freight diversion, travel-time savings, or operational efficiency.

2-Land-Use Change and Corridor-Based Spatial

Pressure

Land-use change along the Urmia–Serow corridor was assessed through visual interpretation of available aerial and satellite images covering the 2006–2023 period. The purpose of this analysis is not to provide a full GIS-based land-use classification or a statistically validated land-use change model. Rather, it aims to identify visible spatial patterns of corridor-based development pressure, agricultural land conversion, and settlement expansion.

(Fig. 5) shows visible land-use transformations along the corridor. The reviewed spatial evidence indicates that parts of the corridor have experienced gradual transformation from agricultural and open lands toward residential, service-related, and built-up uses. These changes suggest that the existing road-oriented corridor has become an important axis for spatial expansion and land-use concentration. Such transformations may be associated with urban growth, accessibility advantages, local economic activity, and weakly controlled development processes.

The visual evidence indicates that parts of the Urmia–Serow corridor are experiencing land-use and development pressure. However, the observed changes cannot be attributed to transport accessibility alone because the present study does not provide a causal land-use model. Within this limitation, a rail-oriented planning scenario may provide a framework for coordinating development around selected nodes, provided that it is supported by station-area planning, land-use regulation, landscape protection, and institutional coordination.

3-Road-Safety Considerations

Field observations documented localized road-condition and roadside-safety concerns along the Urmia–Serow corridor. These observations are used only to identify road safety as a planning consideration and do not constitute a route-specific crash database. Because multi-year official crash records and traffic-exposure measures were not available for this assessment, the study does not estimate baseline crash risk or predict accident reduction under the proposed rail-oriented scenario. (Fig. 6) illustrates examples of road-condition and roadside-safety issues observed along the corridor. Any future safety analysis should use official route-specific crash records together with exposure indicators such as vehicle-kilometers traveled and a dedicated

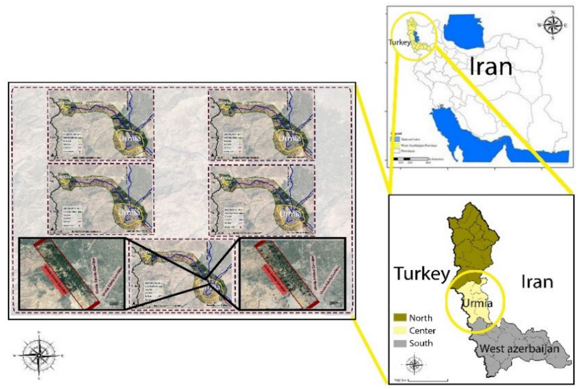

Figure 5: Land-use changes along the Urmia–Serow corridor based on visual interpretation of available aerial and satellite images from 2006 to 2023. (Source: Author)

Figure 6: Examples of road-condition and roadside-safety issues observed along the Urmia–Serow corridor during field observations. (Source: Author)

4-Environmental and Fuel-Consumption Implications

To provide an illustrative estimate of road-based fuel and energy demand, a scenario calculation was performed using route distance, assumed daily traffic volume, and an assumed average vehicle fuel-consumption rate. These inputs are treated as scenario parameters rather than measured fleet-average values. Therefore, the resulting estimates represent illustrative road-based fuel and gasoline-equivalent energy demand and should not be interpreted as measured fuel consumption, emissions, or a complete life-cycle environmental assessment.

Estimated road-based fuel use was calculated using Equation (1):

Estimated road-based fuel use (L/day) =
Route distance (km) × Assumed daily traffic volume (vehicles/day) × Assumed fuel-consumption rate (L/100 km) / 100 (1)

Gasoline-equivalent energy demand was calculated using Equation (2), using an energy content of 34.2 MJ/L for gasoline (Douvartzides et al., 2022):

Estimated gasoline-equivalent energy demand (GJ/day) =
Estimated road-based fuel use (L/day) × 34.2 / 1000 (2)

Using this illustrative calculation, the Urmia–Serow route, with a distance of 55 km, an assumed average fuel-consumption rate of 8.1 L/100 km, and an assumed daily traffic volume of 3,500 vehicles/day, has an estimated road-based fuel use of 15,592.5 L/day. This corresponds to approximately 533.3 GJ/day of gasoline-equivalent energy demand. The same calculation was applied to the other selected corridors presented in Table 2. Table 2 provides an indicative comparison of road-based fuel and energy pressure across selected corridors. The results show that longer corridors and higher assumed daily traffic volumes are associated with greater estimated fuel and energy demand. These estimates help explain why the existing road-oriented transport pattern may create environmental and energy-related pressure along the Urmia–Serow corridor.

The proposed rail-oriented scenario may have environmental relevance if part of passenger and freight movement shifts from road to rail. However, the exact amount of fuel saving or emission reduction cannot be concluded from Table 2 alone. Such estimates would require modal-shift modeling, train operation assumptions, energy-source data, and emission factors. Therefore, Table 2 is used as an indicative planning calculation rather than proof of exact environmental benefits.

Table 2: Illustrative estimates of road-based fuel use and gasoline-equivalent energy demand for selected transport corridors in West Azerbaijan Province. (Source: Authors' illustrative calculation based on route distance, assumed daily traffic volume, assumed vehicle fuel-consumption rate, and gasoline-equivalent energy content).

Route	Distance (km)	Assumed Fuel-Consumption Rate (L/100 km)	Assumed Daily Traffic Volume (vehicles/day)	Estimated Road-Based Fuel Use (L/day)	Estimated Gasoline-Equivalent Energy Demand (GJ/day)
Urmia–Serow	55	8.1	3500	15,592.5	533.3
Serow–Urmia	55	8.1	3500	15,592.5	533.3
Urmia–Salmas	91.8	8.1	3500	26,025.3	890.1
Salmas–Urmia	91.8	8.1	3500	26,025.3	890.1
Salmas–Khoy	44.4	8.1	2800	10,069.9	344.4
Khoy–Salmas	44.4	8.1	2800	10,069.9	344.4
Khoy–3-Rah Evoghli	30.5	8.1	3000	7,411.5	253.5
3-Rah Evoghli–Khoy	30.5	8.1	3000	7,411.5	253.5
3-Rah Evoghli–Maku	121	8.1	3000	29,403.0	1,005.6
Maku–3-Rah Evoghli	121	8.1	3100	30,383.1	1,039.1
Maku–Bazargan	15.1	8.1	3100	3,791.6	129.7
Bazargan–Maku	15.1	8.1	3100	3,791.6	129.7

Note: The traffic-volume and fuel-consumption values are used as scenario assumptions; therefore, the estimates should not be interpreted as measured corridor fuel use or net system energy demand.

5-Proposed Rail-Oriented Scenario and Planning Implications

The proposed rail-oriented scenario for the Urmia–Serow corridor is presented as a conceptual planning alternative rather than as a proven causal intervention. The scenario is developed based on the corridor's existing road-oriented transport pressure, observed land-use changes, road-condition and roadside-safety considerations, and the illustrative estimates of road-based fuel use and gasoline-equivalent energy demand discussed in the previous sections. Therefore, the purpose of this section is to interpret how a rail-oriented development framework could potentially reorganize movement, station-area development, and regional connectivity along the corridor.

(Fig. 7) presents the proposed conceptual rail route alignment for the Urmia–Serow corridor. The alignment is used as a scenario-based planning framework to examine how selected focal points could function as potential station areas and development nodes. In this interpretation, stations are not presented as automatic tools for preventing urban sprawl or informal settlement growth. Rather, they are considered possible planning nodes that may help concentrate access, services, and future development if supported by land-use regulation, station-area planning, and institutional coordination.

To provide an illustrative sensitivity analysis, three assumed road-to-rail transfer scenarios were considered for the Urmia–Serow route: 10%, 20%, and 30%. These scenarios are not forecasts of actual future modal shift. Instead, they show the proportional reduction in the road-based fuel-use component that would result if the assumed road traffic volume decreased by the corresponding percentage. The calculations use the illustrative road-based fuel-use and gasoline-equivalent energy estimates reported in (Tab. 2) and do not include the energy required for rail operations.

Illustrative avoided road-based fuel use was calculated using Equation (3):

Avoided road-based fuel use (L/day) = Estimated road-based fuel use (L/day) × Assumed road-to-rail transfer rate (3)

Avoided road-based gasoline-equivalent energy demand was calculated using Equation (4):

Avoided road-based gasoline-equivalent energy demand (GJ/day) = Estimated gasoline-equivalent energy demand (GJ/day) × Assumed road-to-rail transfer rate (4)

For the Urmia–Serow route, the illustrative road-based fuel-use estimate is 15,592.5 L/day, corresponding to 533.3 GJ/day of gasoline-equivalent energy demand. Under an assumed 10% road-to-rail transfer scenario, the avoided road-based fuel use would be 1,559.3 L/day, corresponding to 53.3 GJ/day of avoided road-based gasoline-equivalent energy demand. Under the 20% and 30% scenarios, these values would increase proportionally, as shown in (Tab. 3).

Table 3: Illustrative road-based fuel-use and gasoline-equivalent energy reductions under assumed road-to-rail transfer scenarios for the Urmia–Serow route. (Source: Authors' illustrative scenario calculation based on Tabale 2).

Scenario	Assumed Road-to-Rail Transfer Rate	Implied Reduction in Assumed Road Traffic Volume (vehicles/day)	Avoided Road-Based Fuel Use (L/day)	Avoided Road-Based Gasoline-Equivalent Energy Demand (GJ/day)
Low-shift scenario	10%	350	1,559.3	53.3
Medium-shift scenario	20%	700	3,118.5	106.7
High-shift scenario	30%	1,050	4,677.8	160.0

Note: The values represent proportional reductions in the assumed road-based component only. They do not account for rail-operating energy and therefore should not be interpreted as net system energy savings.

Table 3 illustrates how the assumed road-based fuel-use component changes under 10%, 20%, and 30% road-to-rail transfer scenarios. These values are arithmetic scenario estimates rather than forecasts of actual modal shift or net energy savings. Their interpretation depends on the assumed reduction in road traffic volume, while the energy required for rail operations is not included in the calculation.

The proposed scenario may also have spatial-planning and road-safety relevance; however, the present analysis does not quantify accident reduction or establish a causal safety effect. Any future assessment of road-safety impacts would require official multi-year route-specific crash data, traffic-exposure indicators, and transport-demand modelling. Similarly, the potential role of station areas in guiding spatial development would depend on land-use regulation, station-area planning, landscape protection, and institutional coordination.

Therefore, the proposed rail-oriented scenario should be understood as a planning framework for further evaluation rather than as evidence of guaranteed fuel savings, environmental benefits, accident reduction, or controlled spatial growth. Its main contribution is to provide a structured basis for considering transport, land-use, environmental, and regional-connectivity issues together in future corridor planning.

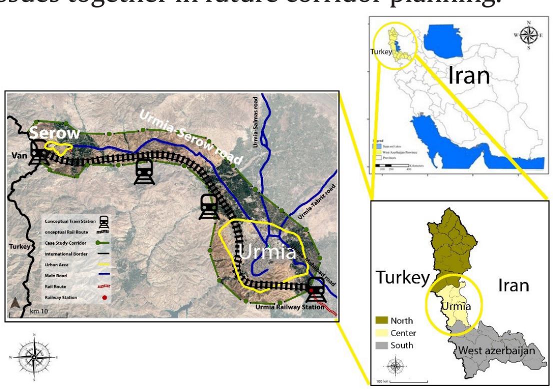

Figure 7: Proposed conceptual rail route alignment for the Urmia–Serow corridor, used as a scenario-based planning framework for evaluating possible station-area development and corridor connectivity. (Source: Kheyroddin and Jamshidi Farkhondeh, 2024)

RESULTS AND CONCLUSION

This study assessed the Urmia–Serow border corridor as a scenario-based case of rail-oriented spatial development in West Azerbaijan Province, Iran. The analysis showed that the corridor is currently characterized by road-oriented transport pressure, visible land-use transformation, road-condition and roadside-safety concerns, and illustrative estimates of road-based fuel use and gasoline-equivalent energy demand. These findings suggest that the corridor should be understood not only as a transport route, but also as a spatial planning corridor where mobility, land use, environmental pressure, and border connectivity intersect.

The proposed rail-oriented scenario is not presented as a guaranteed solution to the corridor's development challenges. Rather, it provides a conceptual and scenario-based planning framework for examining how rail infrastructure could potentially support more coordinated movement, station-area development, and regional connectivity. The scenario-based assessment suggests that rail-oriented planning may help concentrate future development around selected nodes, reduce part of road-based movement under modal-shift assumptions, and support better coordination between transportation and land-use policies. However, these outcomes depend on land-use regulation, institutional coordination, investment capacity, station-area planning, and actual passenger and freight demand.

The fuel and energy calculations presented in this study provide indicative evidence of road-based energy pressure along the corridor. In addition, the modal-shift scenarios show how different levels of road-to-rail transfer could potentially reduce road-based fuel and gasoline-equivalent energy demand. These estimates should not be interpreted as confirmed future fuel savings or emission reductions. Exact environmental benefits would require a full transport-demand model, rail operation assumptions, energy-source data, and emission-factor-based environmental assessment.

Similarly, field observations identify road-condition and roadside-safety issues as planning considerations along the corridor. Because the study does not use a multi-year route-specific crash database or traffic-exposure measures, it does not estimate baseline crash risk or predict accident reduction. Any future safety evaluation would require official route-specific crash records, exposure indicators such as vehicle-kilometers traveled, and transport-demand modelling.

The study also highlights the importance of cross-border and institutional conditions. The potential contribution of a rail-oriented scenario depends not only on the physical alignment of the corridor, but also on coordination between regional authorities, national transport agencies, customs systems, investment priorities, and Iran–Turkey cross-border transport policies. Without such coordination, the corridor's potential role in regional integration and border-related development may remain limited.

Overall, the Urmia–Serow rail-oriented scenario can be considered a planning framework for further evaluation rather than a confirmed development outcome. Its main contribution is to connect transport pressure, land-use organization, environmental considerations, and border connectivity within a single scenario-based assessment. Future research should develop detailed transport-demand models, official accident-data analysis, GIS-based land-use classification, environmental impact assessment, and economic feasibility studies to test the practical viability and long-term impacts of the proposed rail-oriented corridor.

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