CHAPTER 5: SCENARIO EVALUATION

This chapter presents the comparative review of the postulated transport scenarios.

5.1. THE MODELING PROCESS

The MNaM provides the tool by which to compare the transport performance of the various scenarios. Several key interactions occur as the model proceeds through its stages of trip generation, trip distribution, modal split and assignment. Key overview considerations include (refer Section 3.3 for more detailed discussion):

- Future trip generation will change in line with future socio-economic evolution; that is, in case of person trips, more population and higher economic well-being implies more trips. In case of freight, changes in production, consumption, imports and exports, among other variables, will impact generated tonnes of cargo.

- The distribution of trips will change in line with the underlying socio-economic framework. Thus, while trips to/from new development areas could be near zero at present (year 2010), demand could sharply escalate as a new eco-demographic fabric is superimposed onto Egypt in future. The resulting trip origin and trip destination patterns are inexorably linked based on complex time/distance/cost relationships representative of person travel and mode-of-commodity transport.

- The extent and type of available transport networks across all modes govern the choice process of which mode is used to fulfill trip demand. For example, if extensive new road facilities are provided, it may be surmised that an increasing number of trips will choose to use a road mode, whether public or private, to complete the journey. Conversely, the provision of additional higher-order rail and IWT systems are expected to catalyze increased diversion of cargo shipments (depending on commodity) to those modes.

- Intermodal transport, whether for person or cargo transport, is notionally expected to increase as proper stations and mode interchange facilities are provided. The availability of service is, needless to say, a vital issue. In other words, unless rail linkages (whether by direct tracks and/or non-rail feeder services) are available, usage of that mode will not occur with trips instead being “forced” onto whatever other modal infrastructure is available to service the underlying origin-destination pattern.

- The operational quality of the modes impacts modal choice. For example, as more trips choose to utilize road-based modes of transport, operational criteria of roads (speed, capacity) will temporally degrade. That is, increasing congestion on roads will catalyze a diversion of trips to non-road modes. Conversely, public transport operating at inconvenient headways, or slow speeds, will not be conducive to attracting trips to that particular mode, in particular if trip fulfillment is cheaper and/or faster via private modes of transport.

- The modal selection is governed by generalized cost; for example, trip distance, trip time, vehicle operating cost (to include fuel cost), fare levels and value of time. This governs both person and cargo movement as well as private and public forms of transport.

5.2. SCENARIO PERFORMANCE

The evaluation of scenarios is based on a series of cascading applications of the MNaM. Valuable points and technical details were exchanged at the Transport Scenario Workshop of 29 September. As expected, considerable background technical information is available, not all of which can, practically speaking, be included in the current report.

The presentation format in following sections focuses on the main evaluation points of the scenarios, as noted in *Inception Report 2*. These include conformity with transport vision and policy, transport system capacity, environmental impacts, economic efficiency and affordability (Figure 5.2.1).

Conformity with Transport Policy	Non-Road Modal Share (percentage) for Cargo and Person Trip
Transport System Capacity	Road Congestion (percentage of all roads congested), Average of Road Network Speed
Environmental Impacts	Reduction of CO_2 emission (tonnes base)
Economic Efficiency	Benefit *first year* /Cost *(Benefit: VOC saving, Time saving)*
Affordability	Total Project Cost (Road, Rail, IWT)

Source: JICA Study Team

Figure 5.2.1 Scenario Evaluation Criteria

5.2.1 Conformity with Vision and Policy

The road mode is an essential factor in economic activity and has historically played a strong role in modal choice for Egypt. While this phenomena has fulfilled a variety of social goals and expectations, unfettered growth is also contributing to various negative social, economic and environmental impacts. This high level of car usage is a historic consequence of vehicle ownership characteristics, pricing policies (such as the fuel subsidy), supported by "road focused" capital works programs and limitations to public transport services. Increasing car usage is beginning to impact the quality of life. A more balanced approach to providing mobility is desirable. A key focus of MiNTS, strongly supported by both the Study Team and client group, is therefore is the creation and promotion of high quality, multi-modal (and intermodal) transport system for persons and cargo (this is discussed in more detail in the previous *Interim Report 2*). The evaluations of the scenarios therefore focuses on two aspects: diversion of cargoes to non-road (rail, inland waterway) modes of transport, and refocusing the role of passenger transport onto those means of conveyance seen as being compatible with longer trips.

Future demand (year 2027) is expected to approximately double across all modes compared to year 2010 levels. Total person trips is forecast to grow from some 18.5 million daily trips to 33.9 million daily trips. An important subcomponent are “longer person trips”, that is, journeys exceeding 100 kilometers in length. These accounted for 3.5 million person trips in year 2010, a total forecast to grow to 6.1 million trips in 2027. Likewise, shipped cargo tonnes, which totaled 1.2 million tonnes in year 2010 (excluding pipeline) are shown as reaching 2.8 million daily tonnes by year 2027.

The MNaM simulations suggest that, in case of cargo (Table 5.2.1):

- The road mode is expected to retain its vital role; however, the dominance is reduced depending on scenario.
- The impact of doubling the fuel price (for example, for trucks) is reinforced by Scenario C-1 where non-road cargo shipments absorb near five percent of totals.

Table 5.2.1 Modal Split – Year 2027 Cargo Shipments

Scenario	Road	Rail	Inland Waterway	Total
Daily Tonnes				
A	2,742,400	16,700	30,700	2,789,800
B	2,742,400	16,700	30,700	2,789,800
C-1	2,664,300	64,200	61,400	2,789,800
C-2	2,736,800	22,300	30,700	2,789,800
C-3	2,535,600	139,800	114,400	2,789,800
Tonne Modal Allocation (Percent)				
A	98.3	0.6	1.1	100.0
B	98.3	0.6	1.1	100.0
C-1	95.5	2.3	2.2	100.0
C-2	98.1	0.8	1.1	100.0
C-3	90.9	5.0	4.1	100.0
Daily Tonne Kilometers (Million)				
A	633.01	6.13	3.31	642.45
B	647.45	5.78	3.11	656.34
C-1	568.21	37.22	23.48	628.92
C-2	623.21	5.19	2.27	630.67
C-3	517.95	75.72	48.23	641.91
Tonne Kilometer Modal Allocation (Percent)				
A	98.5	1.0	0.5	100.0
B	98.6	0.9	0.5	100.0
C-1	90.3	5.9	3.7	100.0
C-2	98.8	0.8	0.4	100.0
C-3	80.7	11.8	7.5	100.0

Source: JICA Study Team.

- Partial increase in fuel price (Scenario C-2) confirms that the road mode is resuming its overall dominancy by approaching observed modal splits.

- The most optimistic modal split is Scenario C-3, where non-road cargo tonne transport is on the order of 10 percent. Under Scenario C-3, fuel costs have, in year 2010 terms, more than doubled.

- Rail and inland waterway tend to carry “heavier and bulkier” cargoes, often over longer distances, than the road mode. Thus, tonne kilometer modal splits are expected to exceed those of tonne transport. In case of Scenario C-3, for example, the tonne kilometer modal share for non-road modes approaches 20 percent.

The noted modal splits are average national totals. Clearly, diversion to rail and inland waterway modes is strongly influenced by the presence of infrastructure. In case of Scenario C-3, for example, diversion to non-road modes is highest in the core corridor serving both rail and inland waterway, represented by the Upper Egypt Region. Tonne kilometers are shown equally split between road and non-road modes (Table 5.2.2).

Table 5.2.2 Regional Distribution of Year 2027 Cargo Tonne Kilometers: Scenario C-3

Region		Percent by Mode			
Name	Number	Road	Rail	Inland Water Transport	Total
Cairo	1	85.3	11.1	3.6	100.0
Western Delta	2	90.4	5.9	3.8	100.0
Eastern Delta	3	89.0	6.2	4.7	100.0
Upper Egypt	4	47.4	29.7	22.9	100.0
Red Sea	5	97.3	2.7	0.0	100.0
Western Desert	6	100.0	0.0	0.0	100.0
New Valley	7	100.0	0.0	0.0	100.0
Sinai	8	100.0	0.0	0.0	100.0
Total		80.7	11.8	7.5	100.0

Source: JICA Study Team

The increased diversion of cargo from road to non-road modes also carries considerable implications in terms of required infrastructure. In case of road, being the dominant carrier, demand over base year 2010 increases, across all scenarios, by a factor of 2.2 to 2.4 (Table 5.2.3). Thus, road systems are less sensitive to cargo activity in terms of underlying infrastructure required. However, the situation is very different for the rail and IWT modes.

- It may be stated that, for rail and inland waterway, tonnage is expected to increase to year 2027 by factors of 1.7 and 1.4, respectively, assuming the current modal split is largely maintained and given the expected expansion of the Egyptian economy. This situation is represented by Scenarios A and B. Thus, enhancements are required which permit these modes to almost double their present tonnage.

- Rail carriage is shown as increasing by factors of 6.7, 2.3 and 14.6 for Scenarios C-1, C-2 and C-3, respectively. Based on existing annual carriage of 4.04 million tonnes, the year 2027 demand would be 27.1, 9.3 and 58.9 million tonnes, respectively. The highest totals carried by rail over the past decade is on the order of 12 million tonnes; thus, Scenario C-2 can be seen as "regaining past capabilities". That is, under the assumption that having carried such volumes before, rail upgrading can focus on rehabilitation of existing resources with minimal network expansion. However, this is unlikely to be the case for other scenarios, in particular C-3. The notion of carrying near 60 million tonnes is daunting.

- Inland waterway carriage is shown as increasing by factors of 2.9, 1.4 and 5.3 for Scenarios C-1, C-2 and C-3, respectively. Based on existing annual carriage of 2.23 million tonnes (excluding cross-Nile ferry services), the year 2027 demand would be 6.5, 3.1 and 11.8 million tonnes, respectively. This highest recent totals carried by IWT is on the order of three million tonnes; thus, Scenario C-2 can be seen as "regaining past capabilities". However, this is unlikely to be the case for other scenarios, in particular Scenario C-3 (11.8 million tonnes) which his likely to require considerable system upgrades.

Table 5.2.3 Relative Increase in Tonne Shipments: Year 2010 to Year 2027

Scenario	Road	Rail	Inland Waterway	Total
Base Year 2010	1.0	1.0	1.0	1.0
A	2.4	1.7	1.4	2.4
B	2.4	1.7	1.4	2.4
C-1	2.3	6.7	2.9	2.4
C-2	2.4	2.3	1.4	2.4
C-3	2.2	14.6	5.3	2.4

Source: JICA Study Team

The implications for carriage of persons are (Table 5.2.4):

- The air sector ("true" domestic travel without international connections) is likely to remain modest in extent, however, can be challenged by other modes as infrastructure is improved.

- The modal share of passenger cars is, as discussed in Section 4.2 of this report, sensitive to vehicle operating costs, including the price of fuel. Thus, as fuel prices increase modal share falls. Under Scenarios C-1 and C-2 (about 100 percent and 50 percent increases in fuel price but differing road networks) modal share falls from roughly 18 to 11 percent. Under Scenario C-3, which more than doubles the price of fuel, modal share for longer distance car trips falls to eight percent.

Table 5.2.4 Modal Split – Year 2027 Person Travel

Scenario	Air	Car	Shared Taxi	Bus	Rail	High(er) Speed Rail	Total
Daily Person Trips							
A	124,781	1,089,089	1,980,669	1,473,352	1,412,872	0	6,080,763
B	220,333	1,079,346	1,882,524	1,449,681	1,448,880	0	6,080,763
C-1	60,608	631,969	2,181,262	2,077,215	785,015	344,694	6,080,763
C-2	80,227	638,396	2,110,816	2,072,182	877,390	301,753	6,080,763
C-3	76,804	461,390	2,083,399	2,363,700	822,866	272,604	6,080,763
Person Trip Modal Allocation (Percent)							
A	2.1	17.9	32.6	24.2	23.2	0.0	100.0
B	3.6	17.8	31.0	23.8	23.8	0.0	100.0
C-1	1.0	10.4	35.9	34.2	12.9	5.7	100.0
C-2	1.3	10.5	34.7	34.1	14.4	5.0	100.0
C-3	1.3	7.6	34.3	38.9	13.5	4.5	100.0
Daily Person Kilometers (Million)							
A	24.92	301.94	271.16	267.29	218.98	0.00	1,084.29
B	42.40	302.10	259.12	262.60	244.96	0.00	1,111.18
C-1	12.99	180.44	310.97	412.25	118.79	42.32	1,077.75
C-2	16.95	176.63	298.78	420.67	132.70	36.68	1,082.41
C-3	16.28	125.91	295.76	488.52	127.02	33.11	1,086.60
Person Kilometer Modal Allocation (Percent)							
A	2.3	27.8	25.0	24.7	20.2	0.0	100.0
B	3.8	27.2	23.3	23.6	22.0	0.0	100.0
C-1	1.2	16.7	28.9	38.3	11.0	3.9	100.0
C-2	1.6	16.3	27.6	38.9	12.3	3.4	100.0
C-3	1.5	11.6	27.2	45.0	11.7	3.0	100.0

Source: JICA Study Team. Includes long distance trips of more than 100 km in length.

- Under all scenarios, the main benefactor of modal shift are long distance bus services. Under Scenarios A and B (full subsidy) shares hover near 24 percent. However, these escalate to the mid to upper 30's under the C scenarios.

- Shared taxi modal shares remain within defined ranges for all scenarios. This may imply that the shared taxi network is more oriented to shorter trips and functions, to varying degrees, as a de-facto feeder service for bus and rail modes.

- The opportunities for high speed, or higher speed, rail passenger services are noted. However, the modal shares imply that high(er) speed rail passengers may, in fact, be largely "cannibalized" from lower speed rail services.

5.2.2 Road Network Performance

The assignment of vehicle trips onto the road network is based on both person travel and cargo shipments. Thus, the ability of the road network to cope with this demand is governed by a number of considerations including the extent of the road network, the type of road network and overall modal shift.

Findings suggest that (Figure 5.2.1):

- Operating speeds for the C-series of scenarios, all of which include considerably enhanced infrastructure vis-à-vis Scenarios A and B, are considerably higher averaging near 55 kilometers per hour across all road network links. Scenarios A and B, in comparison, average 42-46 km/hr.

- The congestion rate, that is, percent of all road links operating at unacceptable levels of service (defined as a volume to capacity ratio in excess of 0.8) is noticeable higher under Scenarios A and B. This is not surprising given the more limited networks and the fact that full fuel subsidy is in place. Scenarios C1 and C3 record least congestion; again, this is expected in that fuel cost is highest under these scenarios.

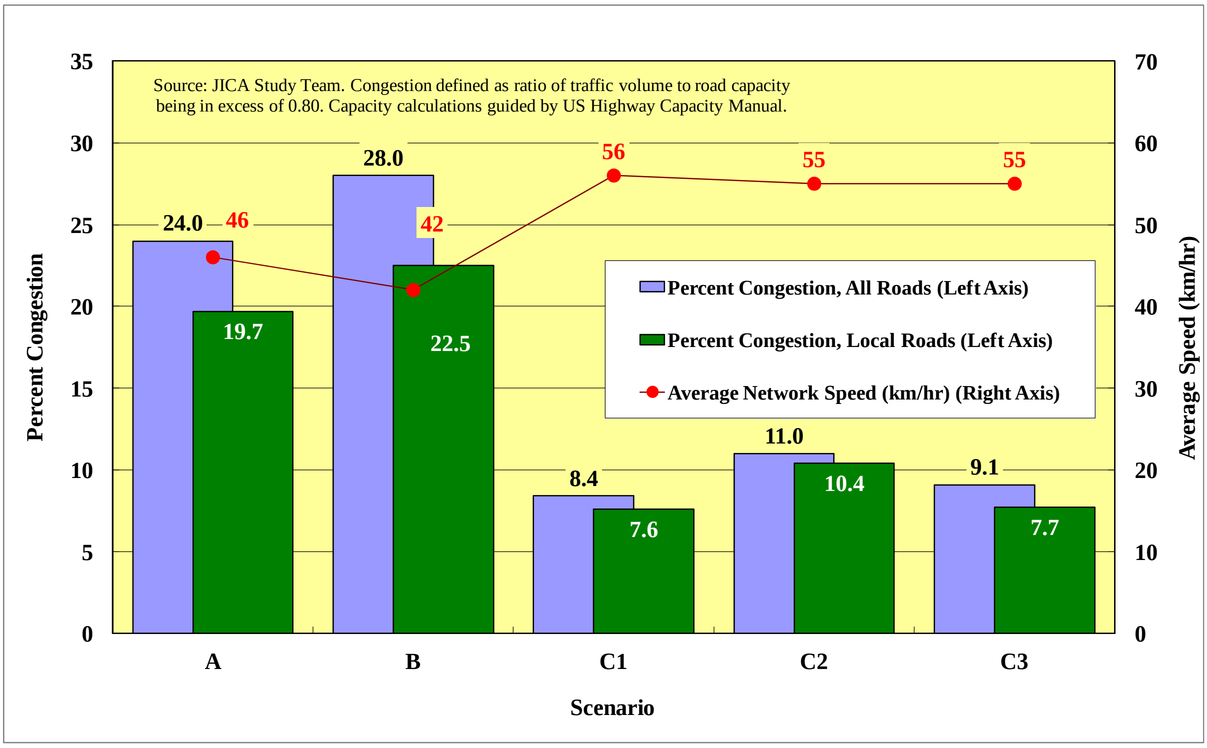
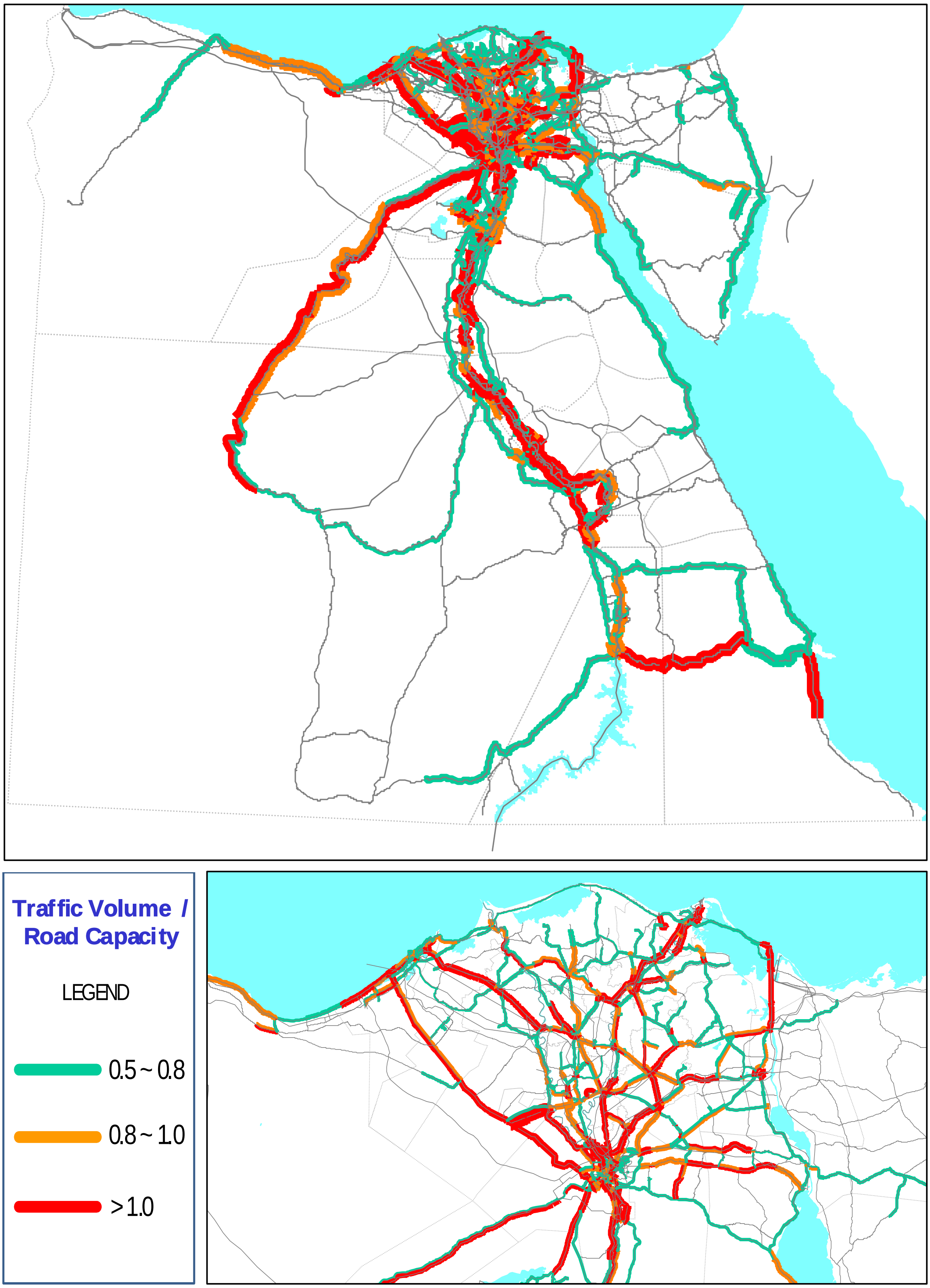


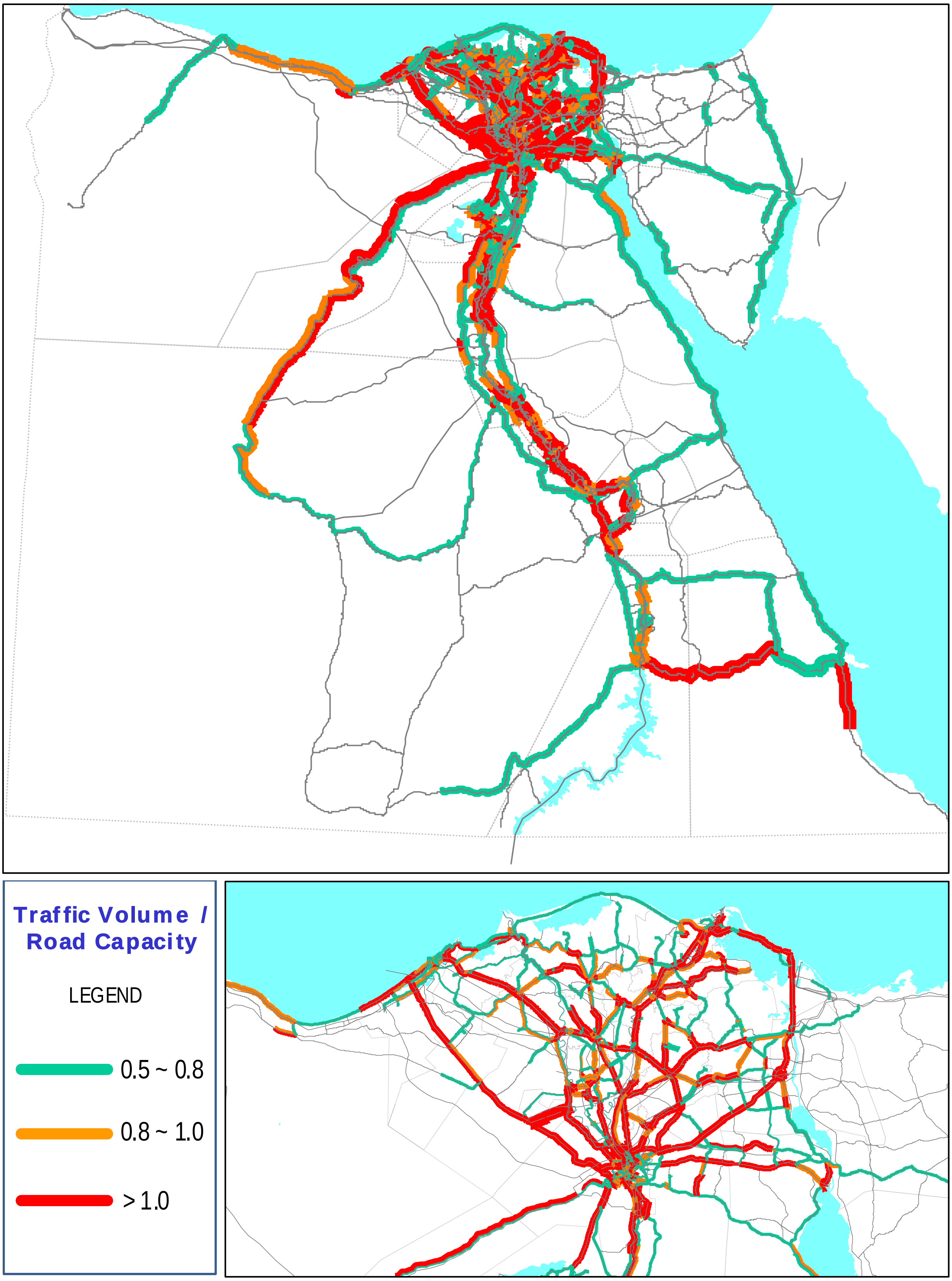
Figure 5.2.1 Comparison of Road Network Performance Indicators

The detailed volume to capacity relationship maps are noted in Figures 5.2.2 through 5.2.6. In simplistic terms, the reduction of "red – congested" links is clearly noted for the C scenarios. However, even under Scenarios C-1,C-2 and C-3, evidence exists that the currently "existing, committed plus planned" highway links (included in the underlying road network) are insufficient to fully absorb forecast demand. Additional projects are required beyond those currently contemplated to address these shortfalls.



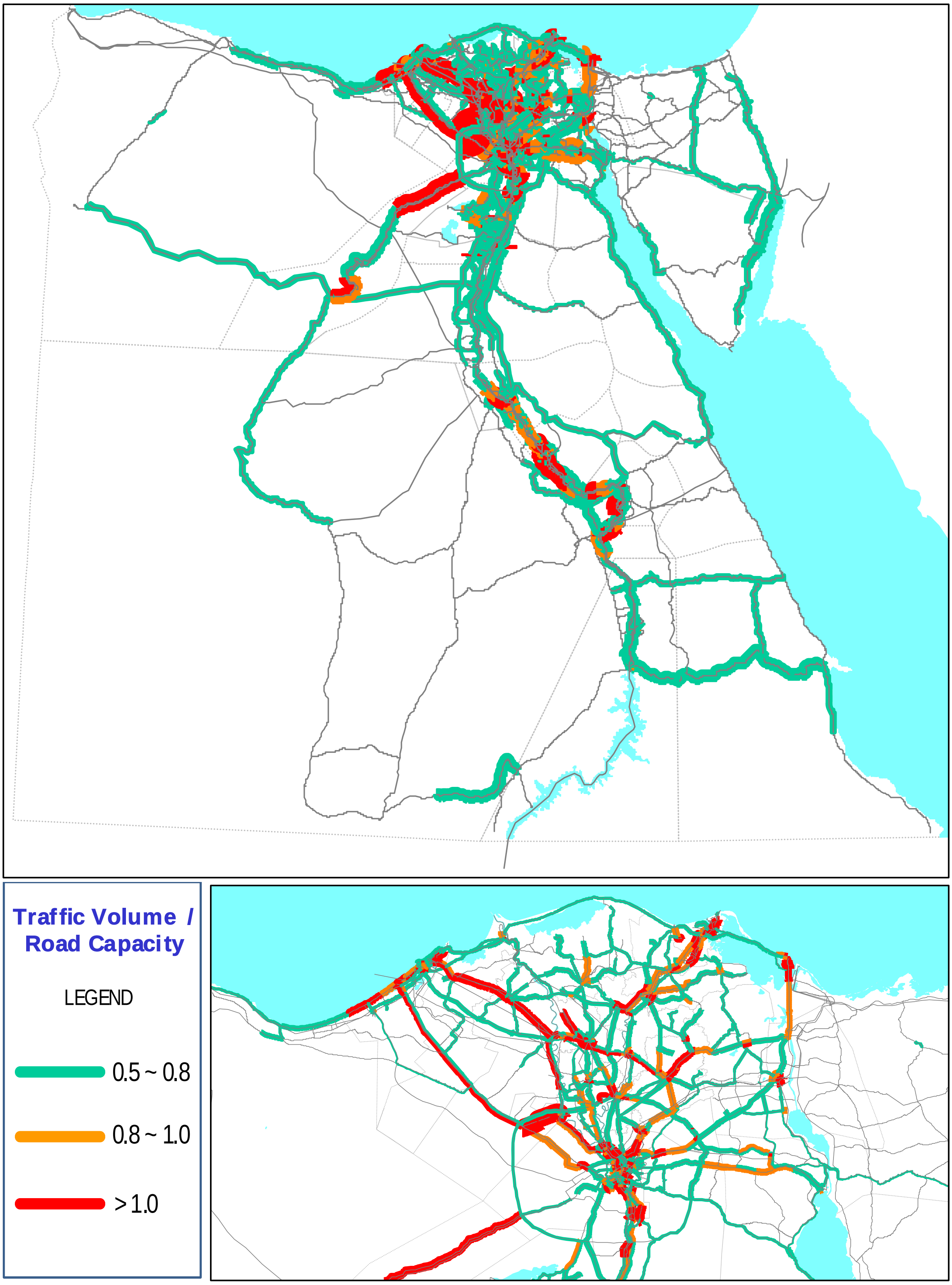
Source: JICA Study Team

Figure 5.2.2 Road Network Volume to Capacity Relationship – Scenario A



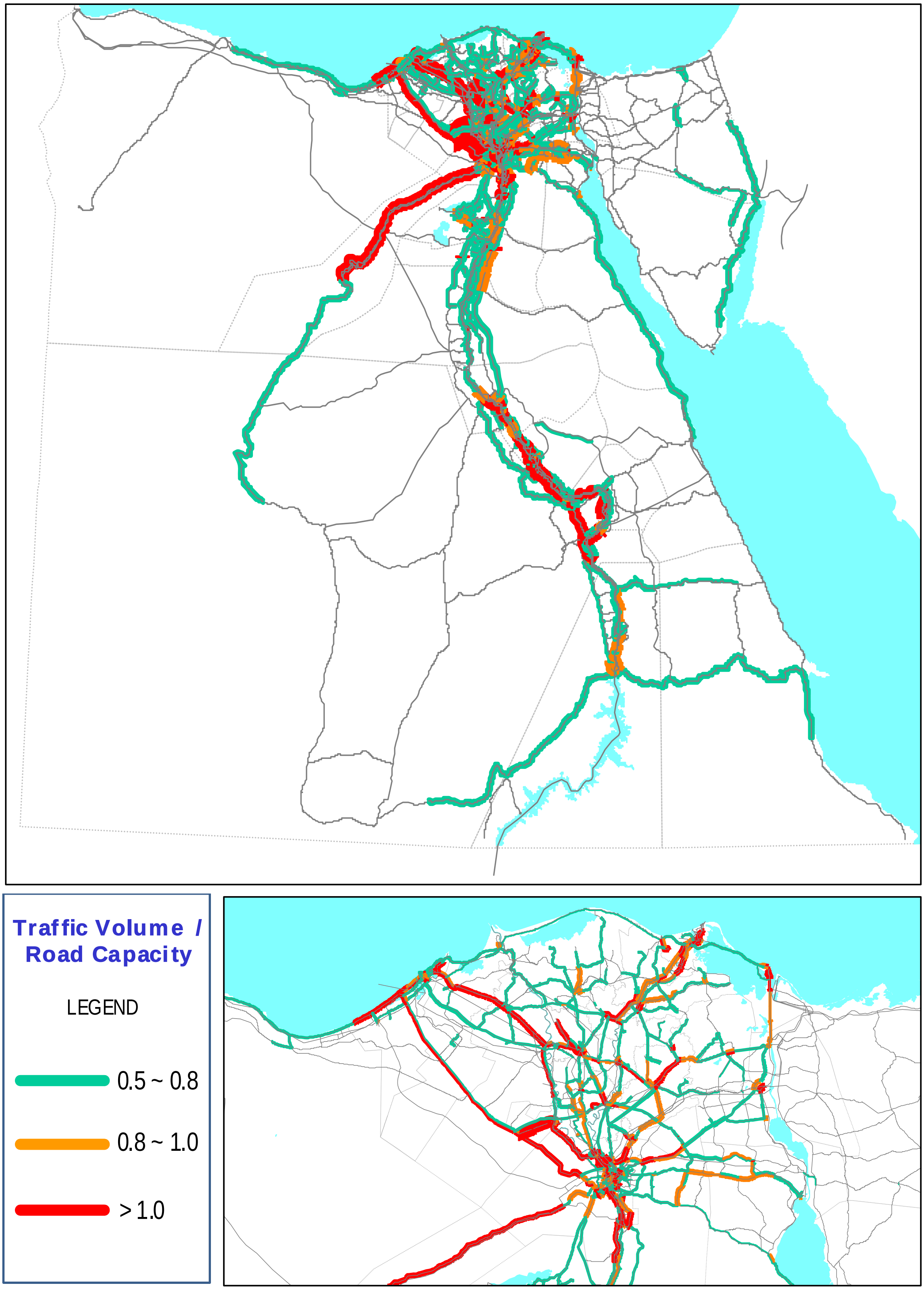
Source: JICA Study Team

Figure 5.2.3 Road Network Volume to Capacity Relationship – Scenario B



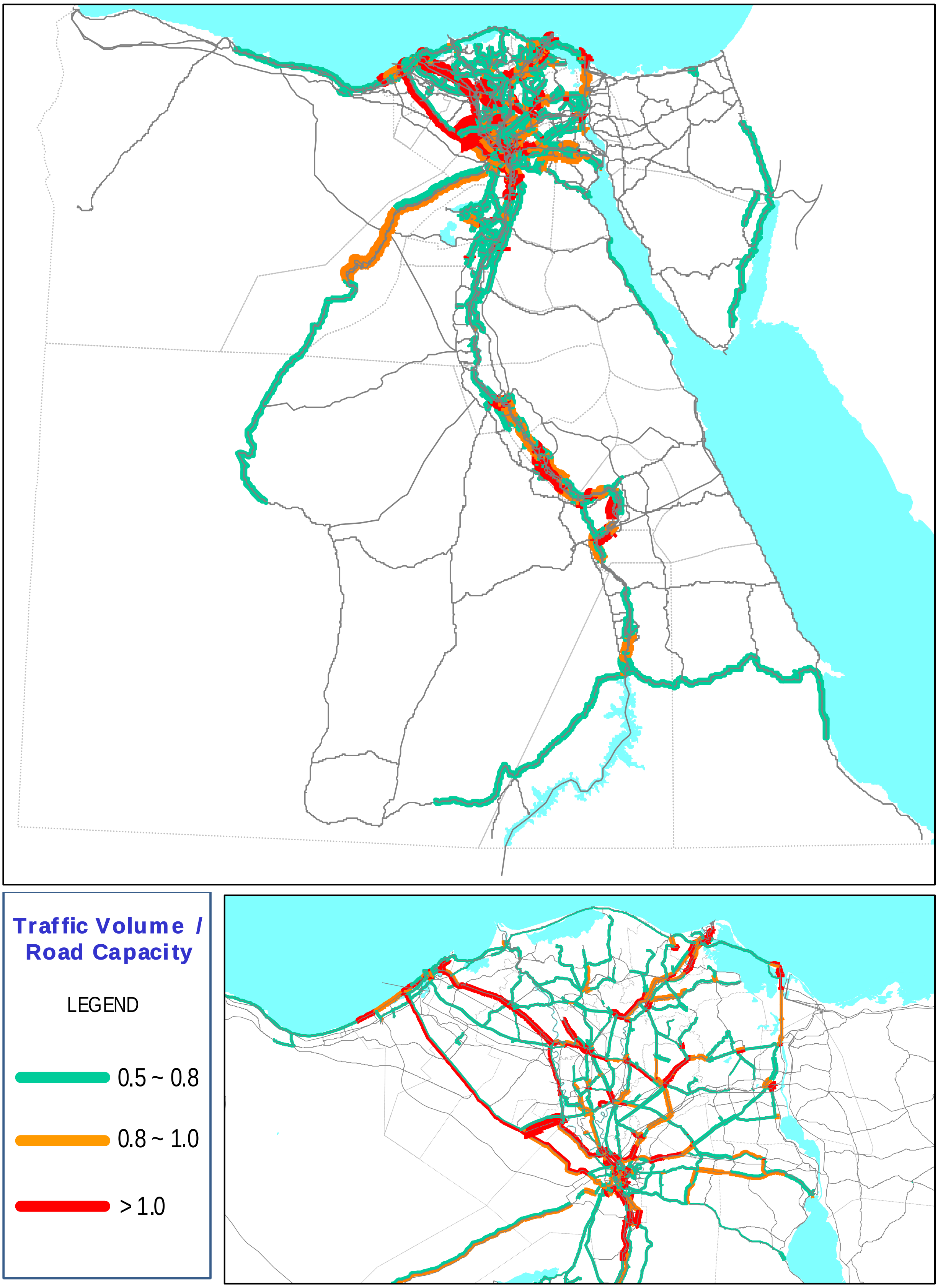
Source: JICA Study Team

Figure 5.2.4 Road Network Volume to Capacity Relationship – Scenario C-1



Source: JICA Study Team

Figure 5.2.5 Road Network Volume to Capacity Relationship – Scenario C-2



Source: JICA Study Team

Figure 5.2.6 Road Network Volume to Capacity Relationship – Scenario C-3

5.2.3 Environmental Impacts

One of the criteria for the selection of the preferred scenario is that the scenario with the best environmental performance should attract a high score in any evaluation of alternative scenarios. Measures that are often considered in the environmental evaluation of transport scenarios include carbon dioxide, carbon monoxide, sulphites and particulate matter. Carbon dioxide is the measure most often linked with greenhouse emissions.

It is for that reason that this measure has been chosen to order the impact of the five transport scenarios on environment performance. Two sources of emission factors were chosen for this analysis. One source, a Japanese source calculates the carbon dioxide emissions using a unit rate based on the variables of person and tonne kilometers whilst another derived from the Asian Development Bank adopt a unit rate bases on vehicle kilometers as a variable (Table 5.2.5).

Table 5.2.5 Carbon Dioxide Emission Factors

Transport Mode	Gram of Carbon Dioxide per Kilometer of Travel		
	Person-Kilometers	Tonne-Kilometers	Vehicle Kilometers
Air	30	-	-
High Speed Rail	6	-	-
Car	45	-	206
Rail	5	37	-
Shared Taxi	19	-	-
Bus	19	-	1,077
Truck	-	273	1,277
Inland Water Transport	-	20	-

Source: JICA Study Team sourcing person and tone kilometers emission factors from the "Outline of Transport Related Statistics(2007)", Ministry of Land, Infrastructure, Transport and Tourism of Japan and sourcing vehicle kilometers emission factors from the Asian Development Bank Sustainable Development Working Paper Series-"Transport and Carbon Dioxide Emissions: Forecasts, Options".

If Scenario B is set at an index of 100, then in the case of Scenario C-1 from both sources, there is a reduction of between 7 percent and 10 percent in carbon dioxide emissions as seen in Table 5.2.6 and Figure 5.2.7. In the case of the more expansive Scenario C-3, the emission reduction varies between 10 percent and 18 percent. Both data sources suggest that even Scenario C-1 will have a positive impact on the reduction of carbon dioxide emission.

Table 5.2.6 Carbon Dioxide Index Number

Scenario	Variable for Emission Estimation	
	Person/Tonne Kilometers	Vehicle Kilometers
A	98	100
B	100	100
C1	89	93
C2	95	95
C3	82	90

Source: JICA Study Team

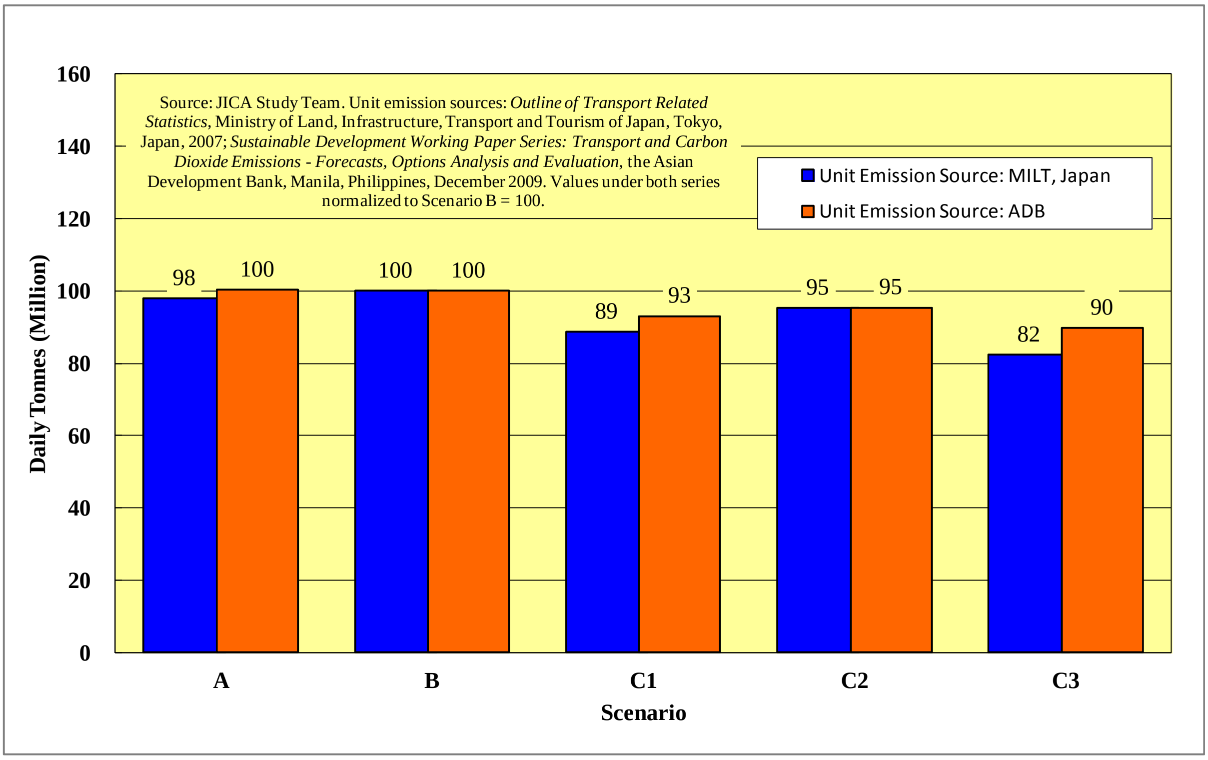


Figure 5.2.7 Comparison of Carbon Dioxide (CO_2) Emissions

5.2.4 Affordability

The cost of the scenarios varies with highest cost being Scenario C-1. This is expected given that this scenario is the most comprehensive in terms of infrastructure. The implementation cost for Scenario C-1 is 249,621 million LE (Table 5.2.5). Some of the differences in rail costs between Scenario C-1 as well as Scenarios C-2 and C-3 can be attributed to a downgrade of high-speed (TVG/Shinkansen-class) systems to higher speed (operating speed 160 - 200 km/hr) systems.

Table 5.2.7 Scenario Implementation Cost (Million LE)

Scenario	Road	Rail	Inland Waterway	Total
A	31,444	5,975	1,125	38,544
B	0	0	0	0
C-1	105,900	142,595	1,125	249,621
C-2	86,005	51,750	1,125	138,880
C-3	86,005	51,750	1,125	138,880

Source: JICA Study Team. Includes initial capital investment. Excludes maintenance and periodic renewal.

The indicated costs do not include outlays for the air and maritime sectors. Also, maintenance and periodic rehabilitation/replacement costs are excluded.

Planning for the transport sector must take into account its fiscal importance and affordability, now and in future. Recent data suggest an annual transport infrastructure investment in vicinity of 20 billion LE. Historically, annual investment has ranged, roughly speaking, from two to three percent of GDP. The year 2009 experience confirms a total GDP share of 2.06 percent, with 1.36 percent derived from public funds, and 0.70 percent from private sector funds (Table 5.2.8). This represents a substantial investment, however, the experiences of fast growing economies such as Vietnam, China and Thailand suggest that expenditure for transport could be increased to the order of two-five percent of GDP. In other words, roughly doubling the historic Egyptian norm. However, whether the Government of Egypt is willing and/or capable of such an initiative cannot be confirmed.

Table 5.2.8 Past Egyptian Transport Investment

Year	Transport Investment (LE billion, current)			Transport Investment (% of current GDP)		
	Public	Private	Total	Public	Private	Total
2003	8.04	1.76	9.80	1.93	0.42	2.35
2004	9.91	2.72	12.63	2.04	0.56	2.60
2005	10.33	2.22	12.55	1.92	0.41	2.33
2006	7.87	7.34	15.21	1.27	1.19	2.46
2007	10.31	5.31	15.62	1.38	0.71	2.10
2008	12.90	12.02	24.92	1.44	1.34	2.78
2009	14.08	7.26	21.35	1.36	0.70	2.06

Source: JICA Study Team based on Ministry of Economic Development data

If similar levels of investment are assumed in future, the allocated amounts must address not only national-level projects such as those contained within MiNTS, but also urban projects, transport projects within urban new developments and investments in maritime as well as air sectors. The Cairo metropolitan area, for example, has, in the early part of the 2000's decade, accounted for roughly one-fourth of national capital transport expenditure. This is unlikely to decrease, and quite possibly increase, in light of commitments towards Cairo International Airport as well as Metro Lines 3 and 4. Obviously, the role of the private sector remains an opportunity. However, as noted in *Interim Report 2*, and borne out by recent experiences, there are few “success stories” for private sector investment in the Egyptian road, rail and inland waterway sectors. The lessons of history thus suggest that a likely expectation is that the majority of funding will arise from public sources, which, historically, have averaged some one to two percent of GDP per annum.

Thus, in light of the various challenges to allocation of the national budget, an initial estimate has been derived based on availability of one-fourth and one-half percent of GDP dedicated purely to MiNTS projects and programs (as defined by the scenario testing process) (Table 5.2.9). This allocation would be in effect each and every year between now and year 2027. This would suggest that sufficient sourcing is possible. However, as noted earlier, additional projects will be required beyond the “existing plus committed plus planned” aspects contained in networks underlying the current MNAM evaluations. Thus, implementation cost, regardless of scenario, is expected to increase.

Table 5.2.9 Affordability Compared to GDP (Million LE)

Scenario	Implementation Cost	Quarter Percent of National GDP	Half Percent of National GDP
C-1	249,621	72,753	145,507
C-2	138,880	72,753	145,507
C-3	138,880	72,753	145,507

Source: JICA Study Team. Includes initial capital investment. Excludes maintenance and periodic renewal. Costs exclude air and maritime sectors. Other possible revenue contributors include private sector investment.

Scenarios C-1, C-2 and C-3 each carry implications in terms of increasing fuel price. This, in turn, carries potential in terms of MiNTS funding (Table 5.2.10).

- Increasing fuel price, that is, a simulated de-facto adjustment of the fuel subsidy, will release considerable commitments in terms of governmental expenditure. Current estimates are that the gasoline and diesel subsidy consumes some three per cent of GDP, in aggregate more than the historic commitment to investment in transport infrastructure. Once the subsidy is removed, additional funds can become available for investment in other sectors of society, including transport. Even over a reduced 10 year period, funding for the currently proposed scenarios can largely be derived from allocation of a future partial equivalencies of the current fuel subsidy.

- Scenario C-3 more than doubles fuel price, that is, a simulated imposition of “at the pump” fuel tax. Whether such a tax will be levied, and to which financial account the proceeds would be allocated, remains unknown. However, considerable amounts of the MiNTS implementation budget could be derived via such a strategy.

In conclusion, considerable financial resources will be required to realize the currently conceived MiNTS project package. These totals are expected to increase as the Master Plan moves toward fruition and its final form. The implementation will require considerable will and commitment on part of the Government, not only in terms of financial resources but also having a steadfast and consistent approach towards realizing the proposed transport vision for Egypt.

Table 5.2.10 Affordability Compared to Alternative Governmental Funding Sources (Million LE)

Scenario	Implementation Cost	Fuel Subsidy Equivalence to Planned Projects		Carbon/Fuel Tax Allocation to Planned Projects	
		25 Percent	50 Percent	25 Percent	50 Percent
C-1	249,621	98,100	196,200	0	0
C-2	138,880	56,700	113,400	0	0
C-3	138,880	96,300	192,600	114,300	228,600

Source: JICA Study Team. Includes initial capital investment. Excludes maintenance and periodic renewal. Costs exclude air and maritime sectors. Carbon tax receipts exclude revenues from urban trips. Carbon tax structured to represent about 20 percent of fuel costs in operating cost calculations. Revenue streams over 10 year period. Other possible revenue contributors include private sector investment.

5.2.5 Economic Efficiency

One of the criteria for the selection of the preferred scenario is that the scenario with good economic performance should attract a high score in any evaluation of alternative scenarios. For even a preliminary economic evaluation, it is necessary to estimate both the project costs and the economic benefits associated with each scenario. The economic benefits are estimated from savings in both in operating costs for both person and cargo and transport operational cost savings in the case of cargo.

The economic implications are presented in Table 5.2.11. Scenario A incurs the lowest cost of any of the scenario but is associated with a relative low return of economic benefits. Scenarios C-1, C-2 and C-3 incur a capital cost increase of the order of around three times. However, the evaluation of these scenarios results in an increase in economic benefits or savings of more than seven times of that as Scenario A. (Scenario B is used as the base in the estimation of economic savings.) A comparison of the ratio of the annual economic benefits to scenario costs suggests that Scenario C-3 performs best in economic terms (Figure 5.2.8).

Scenario C-3 incurs reduced infrastructure costs in comparison to C-1 and at the same time results in increased benefits. This scenario is also likely to result in good financial performance for government as the basis of this scenario is a carbon tax.

In the case of the scenario evaluation, economic benefits include only the savings from vehicle operating costs and travel time. Savings from reduced accidents in particular road accidents are not explicitly included in economic benefits. However, in the case of road accidents, there is a relationship between vehicle kilometers of travel and accidents. As Scenario C-1, C-2 and C-3 result in a reduction of vehicle kilometers of travel, these scenarios are also expected to catalyze significant accident savings.

Table 5.2.11 Implementation Cost and Economic Savings

Scenario	Scenario Implementation Cost (mil LE)	Annual Economic Benefits (mill LE)	Ratio of Annual Economic Benefits to Economic Costs
A	31,444	20,536	0.53
B	0	-	-
C1	105,900	153,090	0.61
C2	86,005	140,269	1.01
C3	86,005	160,470	1.16

Source: JICA Study Team

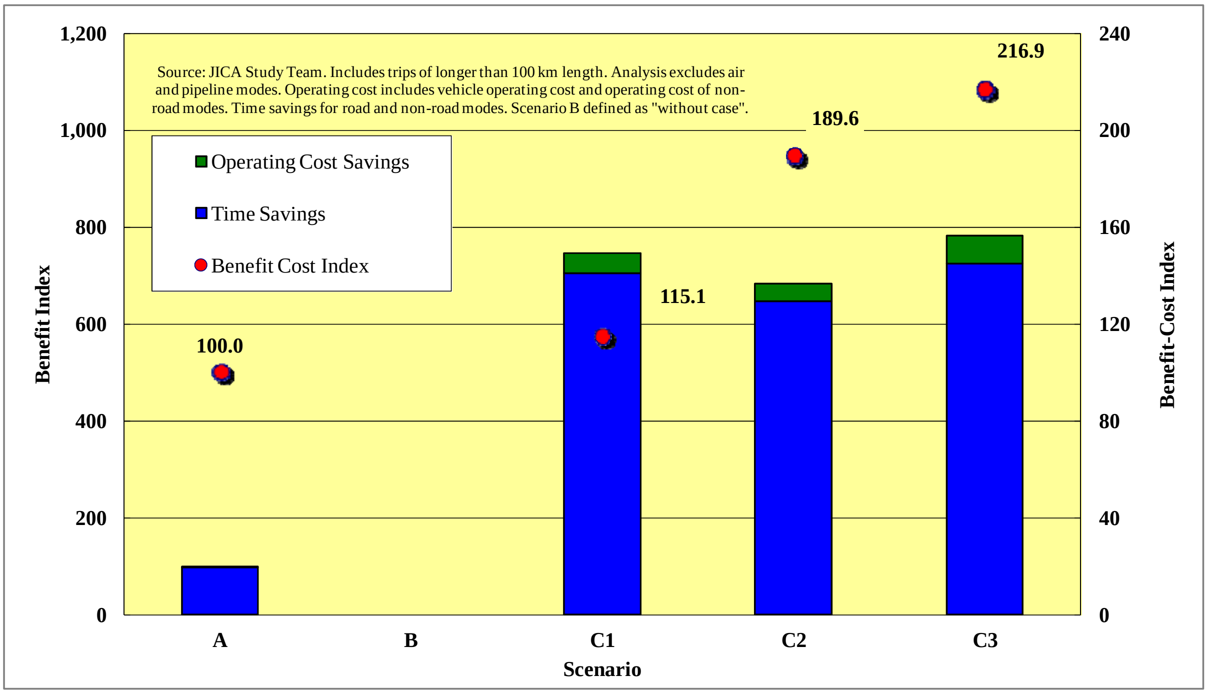


Figure 5.2.8 Comparison of Economic Performance Indicators

5.3. SPECIFICATION OF PREFERRED SCENARIO

In a synoptic sense, the review of the scenarios suggests that:

- The road mode is expected to continue its cargo transport dominancy, most certainly so in case of shorter trips. Nevertheless, and particularly within key corridors, attractive opportunities for cargo transport via rail and IWT exist.

- The road mode is dominant in terms of passenger transport. Future scenarios suggest that modal preferences can, for longer distance trips, be shifted towards large buses with shared taxis providing, in principle, an enhanced feeder service role. The opportunities for "true domestic" air passenger travel is, vis-à-vis other modes, modest.

- The construction of infrastructure across all modes is, in isolation, unlikely to catalyze significant changes in modal split among the various modes.

- Current transport costs, hence modal choice, appear to be strongly impacted by the fuel subsidy. Simulations suggest that "leveling the market place" by eliminating (or reducing) the fuel subsidy will have a considerable effect on modal choice.

- Introduction of an "at the pump" tax, ideally coupled with adoption of market fuel price, will support additional shifts towards non-road modes in terms of cargo while representing a considerable potential dedicated funding source for transport.

The various methodologies, findings, nuances, opportunities and constraints associated with the review of transport scenarios was discussed at the 29 September *Workshop on Transport Scenarios*. The final conclusions in terms of a preferred scenario retain sensitivity towards following points:

- The evaluation indicators would suggest that Scenario C-3 is the preferred option. However, concurrently, it must be noted that one of the key underlying catalysts within this scenario is a more than doubling of fuel prices (in year 2010 terms). A portion of this simulated increase is in the form of an "at the pump" fuel/carbon tax. While it was acknowledged that this presents an excellent opportunity for possibly establishing a dedicated source of transport funding, considerable doubts remain as to the political and social will necessary for the imposition of such a measure.

- While considerable modal cargo shift to non-road modes has been achieved under Scenario C-3 (about 10 percent on a tonne basis, and 20 percent on a tonne kilometer basis), there remain concerns of the ability of rail and IWT networks to absorb such large increases over the coming 20 years. For example, the implication for rail is a carriage of some 60 million year 2027 tonnes. This is a daunting prospect given that highest recent capability has been on the order of 10-12 million tonnes. In that sense, Scenario C-2 appears in a much more favorable light in that indicated carriage for rail and IWT approximate a regaining of recent (say over the last decade) maximum volumes transported. Even that, in a relative sense, would imply a doubling or tripling of rail transport over observed year 2010 volumes, and a considerable increase in IWT longer-distance cargoes (excludes short distance and cross-Nile cargo carriage).

- There appears, on the other hand, much more positive support for roughly doubling of fuel prices (in real terms) over the MiNTS planning horizon. The difficulty of achieving such a de-facto subsidy adjustment within an Egyptian context was noted during the workshop; however, optimism prevailed in that a gradual increase in costs is achievable. Thus, the preferred scenario will, as was the case with Scenarios C-1 and C-3, reflect a costing approach for year 2027 conditions based on "user pay" principles.

- It was noted the testing of the scenarios was, of necessity, an "infrastructure-centric" approach. Further steps within MiNTS, and most certainly the formulation of the final transport plan, will be based, as noted during numerous previous instances prior to the workshop, upon three core pillars: humanware, hardware and software.

- Workshop discussions strongly noted a need to address the negative impacts of road accidents.

- Transport networks to be used in subsequent detailing of the preferred scenario, should (a) exclude (as per Scenario C-2) any high speed rail (TGV/Shinkansen-class) systems and instead employ a more expanded role for high speed (operating speed 160 km/hr – 200 km/hr) systems; (b) additional road infrastructure is implied to ameliorate identified high-congestion links; (c) a focus on intermodal and/or logistics facilities to support the transfer of both persons and goods among the various modes; and, (d) structure networks via a balanced systems approach recognizing both quantitative (MNAM outputs) plus qualitative (vision, policy, strategy) parameters.

The Preferred Scenario

The MiNTS Study Team is, based on discussions during the 29 September workshop, recommending that the preferred scenario should consist of a hybrid between Scenarios C-1 and C-2; to wit:

- Analtical procedures to adopt a “user pay principle” vis-à-vis the market cost of fuel. That is, operating cost calculations reflect an approximate doubling of fuel price (as per Scenario C-1), in constant year 2010 terms, over the 20 year MiNTS planning horizon;
- Networks across all modes are to be derived recognizing both quantitative (MNAM outputs) plus qualitative (MiNTS vision, policy and strategy) parameters.
- Rail networks will not consider any TGV/Shinkansen-class systems, instead focus on higher speed systems (operating speed 160-200 km/hr) as per Scenario C-2;
- The road transport networks will tend towards improvements consisting of existing plus committed plus planned projects, as per Scenario C-1;
- As befitting a national-scope transport study, MiNTS planning must focus on longer distance trips. This excludes, by definition, urban trips in the road sector, commuter services in the railway sector and cross-Nile ferry services (and similar) in the inland water sector; and,
- The need for enhanced intermodal and/or logistics systems is to be fully considered to ensure full potential for the movement of persons and goods among the various modes.

The detailing of the preferred scenario is expected to follow, and yield a series of projects and programs. These will be prioritized in consultation with the client group using GAM/MCA (goal achievement matrix; multiple criteria analysis) approach.

5.4. THE PREFERRED SCENARIO

As discussed in the previous section, the preferred scenario now referred to as Scenario D is a hybrid of the earlier scenarios C1 and C2. It incorporates the principle of market fuel price but not an “at the pump” or environmental tax[1]. The preferred scenario now includes an extended high speed rail link from Alexandria to Aswan albeit at the lower average operational speed of 200 kph. A significant new intermodal freight corridor is now included linking the Red and Mediterranean Seas with a value added logistic entre to the west of the 6th October City.

5.4.1 Conformity with Vision and Policy

The road mode remains dominant under the preferred scenario as would be expected in Egypt. However a key focus of MiNTS, is the creation and promotion of high quality, multi-modal (and intermodal) transport system for persons and cargo. The performance of the preferred scenarios therefore focuses on two aspects: diversion of cargoes to non-road (rail, inland waterway) modes of transport, and refocusing the role of passenger transport onto those means of conveyance seen as being compatible with longer trips.

The MNaM simulations suggest that, in case of cargo for the preferred scenario as stated in Table 5.4.1:

- The road mode is expected to retain its vital role; however, the dominance is reduced.
- The modal share of the non- road sector increases two fold in comparison to the ongoing projects of Scenario A.

It may be stated that, for rail and inland waterway, tonnage is expected to increase even more in comparison to year 2010 namely by a factors of 5.8 and 2.6, respectively, in the preferred scenario as shown in Table 5.4.2. Thus, enhancements are required which permit these modes to almost double their present tonnage.

The implications for carriage of persons are (Table 5.4.3):

- The modal share of passenger cars is, as discussed earlier in this report, sensitive to vehicle operating costs, including the market price of fuel. Thus, as fuel prices increase modal share falls. Under Scenarios C-1 and D (about 100 percent increases in fuel price but differing road networks) modal share falls from roughly 18 to 15 percent.
- The introduction of extended HSR infrastructure in Scenario D including the link from Cairo to Aswan attracts modal share from road based public transport in particular between Scenario C1 and D, the modal passenger share for bus and shared taxi decreases by 7% and 8.5% respectively.
- The additional road network and improved operation of the road network attracts some trips back to the car mode.

[1] During the September workshop, this was referred to as a Carbon Tax.

Table 5.4.1 Modal Split – Year 2027 Cargo Shipments[2]

Scenario	Road	Rail	Inland Waterway	Total
Daily Tonnes				
A	2,742,400	16,700	30,700	2,789,800
C-1	2,664,300	64,200	61,400	2,789,800
D	2,678,200	55,800	55,800	2,789,800
Tonne Modal Allocation (Percent)				
A	98.3	0.6	1.1	100.0
C-1	95.5	2.3	2.2	100.0
D	96.0	2.0	2.0	100.0
Daily Tonne Kilometers (Million)				
A	633.01	6.13	3.31	642.45
C-1	568.21	37.22	23.48	628.92
D	579.02	39.18	23.15	641.35
Tonne Kilometer Modal Allocation (Percent)				
A	98.5	1.0	0.5	100.0
C-1	90.3	5.9	3.7	100.0
D	90.3	6.1	3.6	90.28

Source: JICA Study Team.

Table 5.4.2 Relative Increase in Tonne Shipments: Year 2010 to Year 2027

Scenario	Road	Rail	Inland Waterway	Total
Base Year 2010	1.0	1.0	1.0	1.0
A	2.4	1.7	1.4	2.3
C-1	2.3	6.7	2.9	2.3
D	2.3	5.8	2.6	2.3

Source: JICA Study Team

[2] Tables 5.4.1, 5.4.2 and 5.4.3 include only selected scenarios for comparative purposes. The results of all scenarios are presented in Tables 5.3.2, 5.3.3 and 5.3.4 respectively.

Table 5.4.3 Modal Split – Year 2027 Person Travel

Scenario	Air	Car	Shared Taxi	Bus	Rail	High Speed Rail	Total
Daily Person Trips							
A	124,781	1,089,089	1,980,669	1,473,352	1,412,872	0	6,080,763
C-1	60,608	631,969	2,181,262	2,077,215	785,015	344,694	6,080,763
D	66,518	885,238	1,632,491	1,617,833	936,607	815,853	5,954,540
Person Trip Modal Allocation (Percent)							
A	2.1	17.9	32.6	24.2	23.2	0.0	100.0
C-1	1.0	10.4	35.9	34.2	12.9	5.7	100.0
D	1.1	14.9	27.4	27.2	15.7	13.7	100.0
Daily Person Kilometers (Million)							
A	24.92	301.94	271.16	267.29	218.98	0.00	1,084.29
C-1	12.99	180.44	310.97	412.25	118.79	42.32	1,077.75
D	13.36	253.88	221.05	301.88	138.18	131.58	1,059.93
Person Kilometer Modal Allocation (Percent)							
A	2.3	27.8	25.0	24.7	20.2	0.0	100.0
C-1	1.2	16.7	28.9	38.3	11.0	3.9	100.0
D	1.3	24.0	20.9	28.5	13.0	12.4	100.0

Source: JICA Study Team. Includes long distance trips of more than 100 km in length.

5.4.2 Road Network Performance

Findings suggest that for Scenario D (Figure 5.4.1):

- The performance of Scenarios exhibits a strong network performance.
- The congestion rate is noticeably improved for both all roads and local roads.

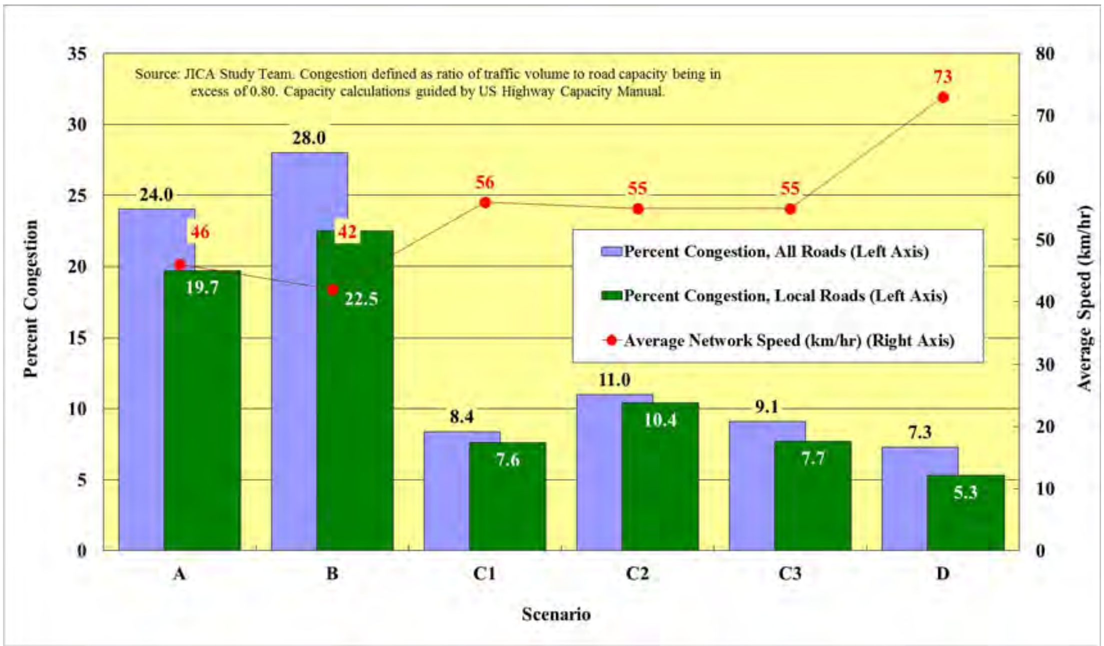
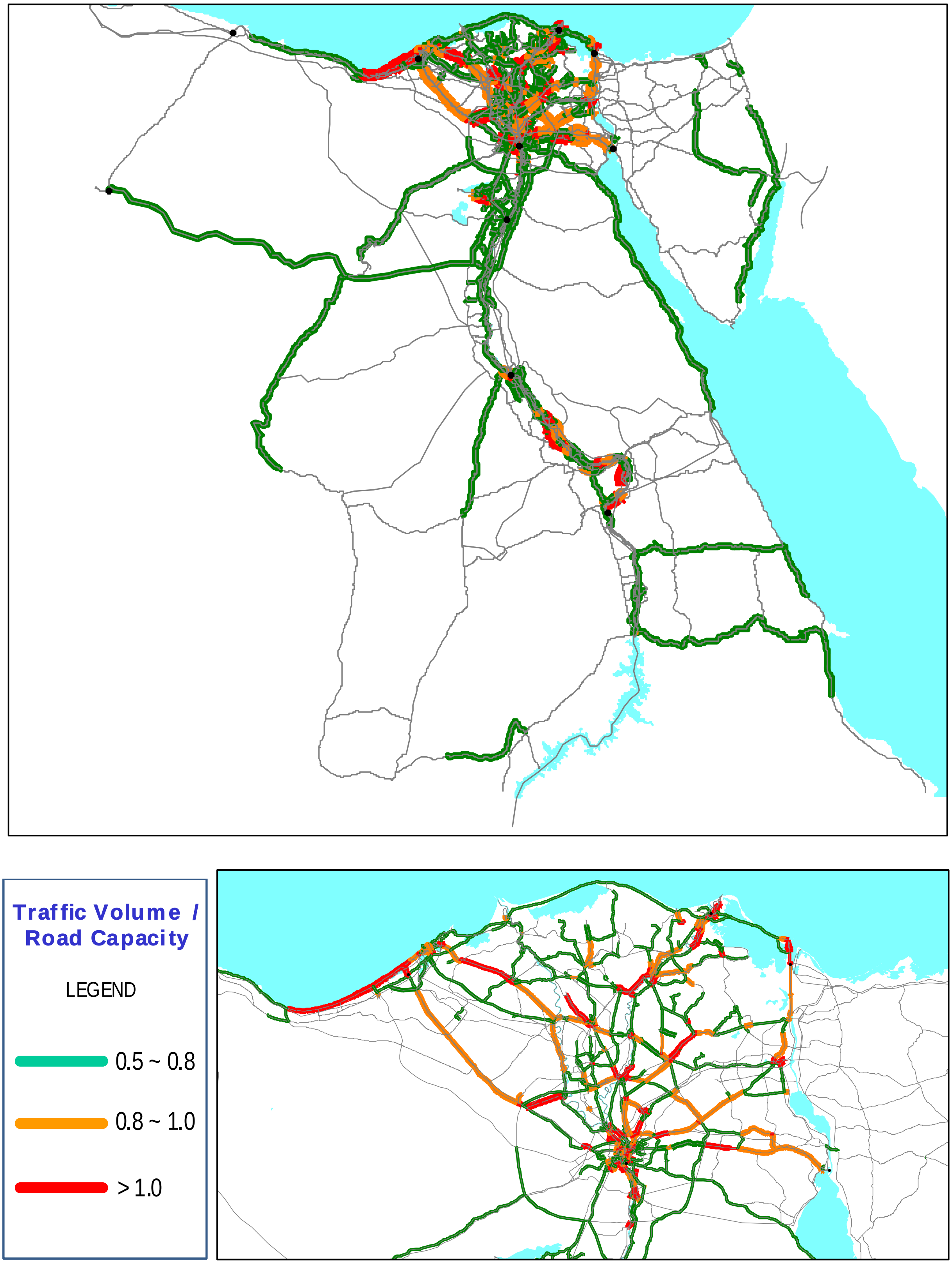


Figure 5.4.1 Comparison of Road Network Performance Indicators

- As seen in Figure 5.4.2, there are only isolated sections of the network operating at a volume to capacity ratio in excess of unity.



Source: JICA Study Team

Figure 5.4.2 Road Network Volume to Capacity Relationship – Scenario D

5.4.3 Environmental Impacts

One of the criteria for the selection of the preferred scenario is that the scenario with the best environmental performance should attract a high score in any evaluation of alternative scenarios. Measures that are often considered in the environmental evaluation of transport scenarios include carbon dioxide, carbon monoxide, sulphites and particulate matter. Carbon dioxide is the measure most often linked with greenhouse emissions. It is for that reason that this measure has been chosen to order the impact of the five transport scenarios on environment performance.

If Scenario B is set at an index of 100, then in the case of both Scenario C-1 and D from both sources, there is a reduction of between 7 percent and 10 percent in carbon dioxide emissions as seen in Figure 5.4.3. In the case of the more expansive Scenario C-3, the emission reduction varies between 10 percent and 18

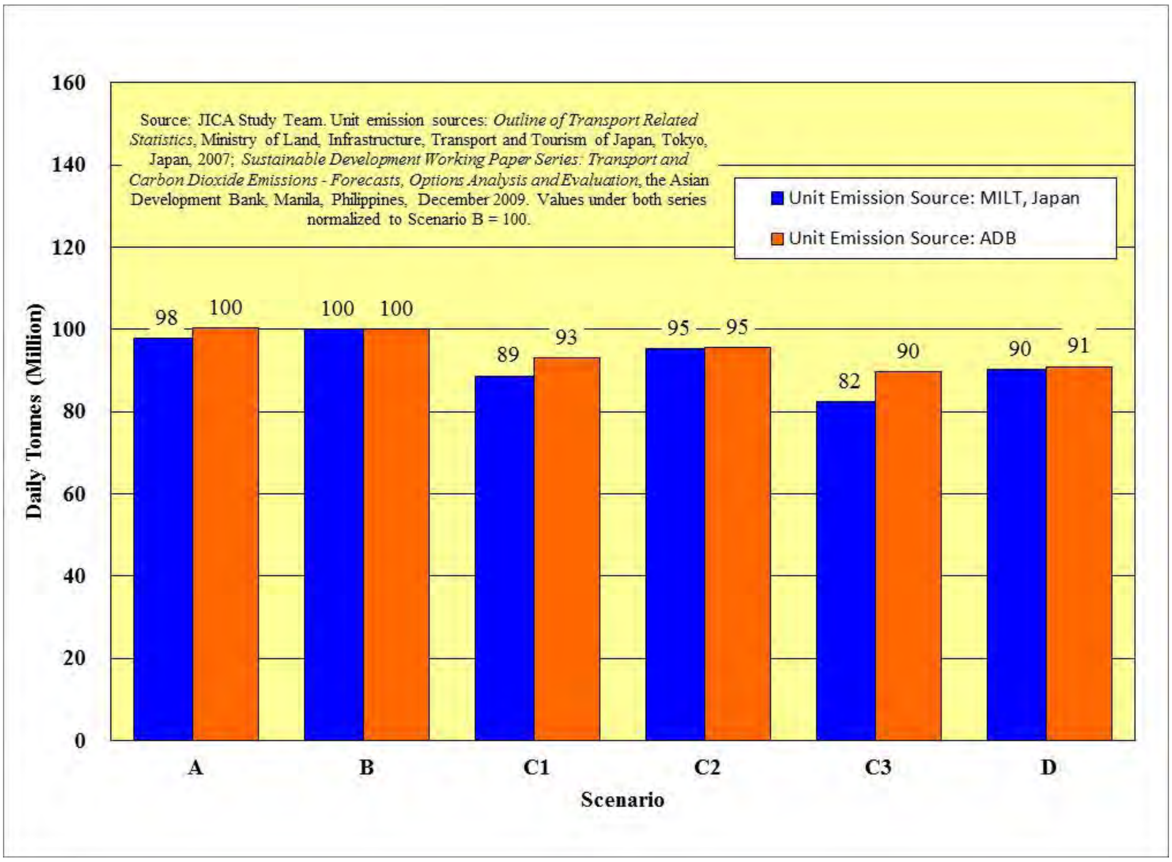


Figure 5.4.3 Comparison of Carbon Dioxide (CO_2) Emissions

percent. Both data sources suggest that even Scenario D will have a positive impact on the reduction of carbon dioxide emission.

5.4.4 Affordability

The cost of the scenarios varies with highest cost being Scenario D as this scenario includes the most extensive HSR network. A detailed cost analysis of the project list included in the preferred scenario is presented later in this report. The issue of affordability must also be considered in association with budget availability. The cost of infrastructure has thus increased significantly to around 300 billion LE in comparison to 250 billion LE noted in Table 5.2.7 for Scenario C1.

5.4.5 Economic Efficiency

One of the criteria for the selection of the preferred scenario is that the scenario with good economic performance should attract a high score in any evaluation of alternative scenarios. For even a preliminary economic evaluation, it is necessary to estimate both the project costs and the economic benefits associated with each scenario. The economic benefits are estimated from savings in both in operating costs for both person and cargo and transport operational cost savings in the case of cargo.

The economic implications are presented in Figure 5.4.4. Scenario A incurs the lowest cost of any of the scenario but is associated with a relative low return of economic benefits. Scenarios C-1, C-2 and C-3 incur a capital cost increase of the order of around three times whilst he capital cost of Scenario D is even higher. However, the evaluation of Scenarios results in an increase in economic benefits or savings of more than ten times of that as Scenario A. (Scenario B is used as the base in the estimation of economic savings.) A comparison of the ratio of the annual economic benefits to scenario costs suggests that Scenario D performs good in economic terms.

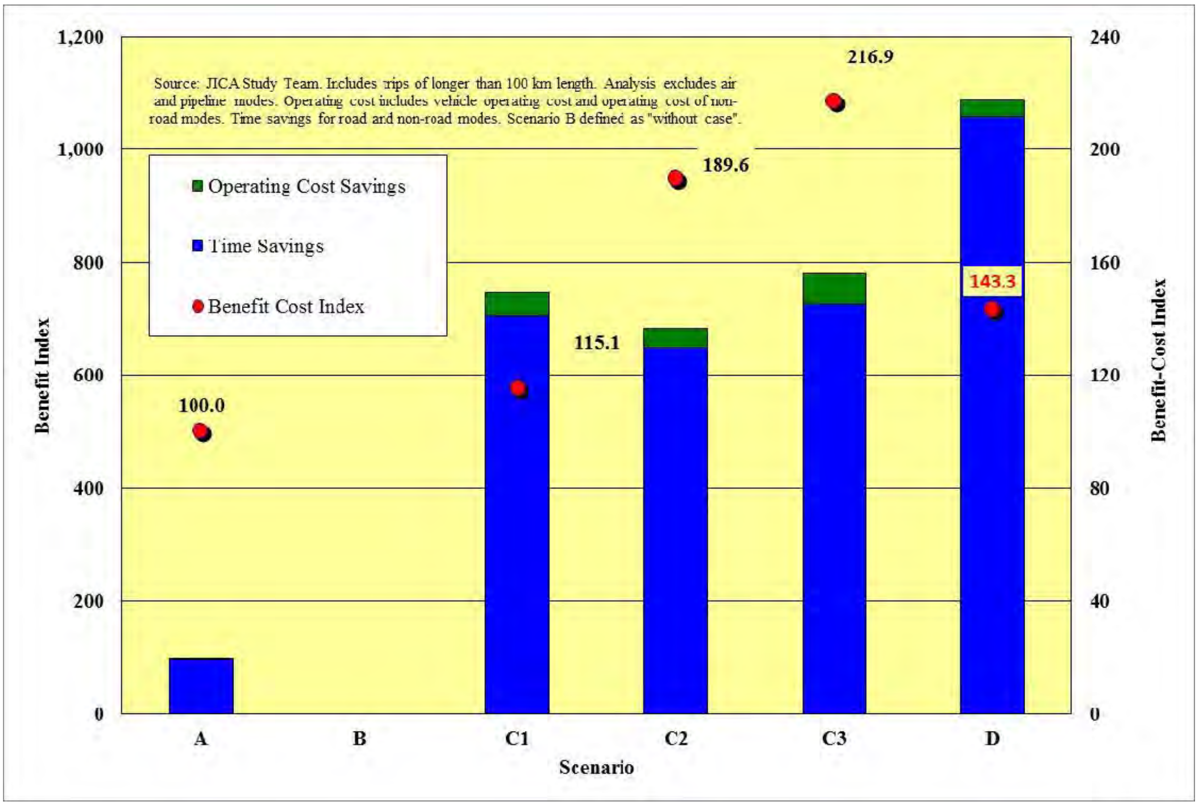


Figure 5.4.4 Comparison of Economic Performance Indicators