Impact of the Strong Republic Nautical Highway on the Movement of Selected Agricultural Goods in the Philippines

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Abstract: The Philippines is an archipelago of approximately 7,107 islands. It has a long coastline that extends to 36,289 kilometers. One of the persistent issues raised by shippers was the high cost of transport from Mindanao to Manila. Among others, Roll-on/roll-off (Ro-Ro) shipping was proposed as a solution to the transport problem. In 2003 the Strong Republic Nautical Highway (SRNH) was formally launched and consists of three main nautical highways: the Western Nautical Highway, the Central Nautical Highway, and the Eastern Nautical Highway. Currently, only the Western Nautical Highway is analyzed in this study since it is the only fully operational network in the SRNH. After the integration of the nautical highway system, many areas were developed, the inter-island shipping industry was restructured, transportation costs were reduced, tourism was enhanced, and logistics operations and strategy of industries were changed. This study identified and assessed the impact of the SRNH on the movement of perishable agricultural goods specifically palay and banana, from Mindanao to Manila. The movement of the goods (banana and palay) is evaluated based on the production and consumption of each region. The evaluation of the cost for each trip and trip distribution were analyzed using operations research (optimization), transportation model, and transshipment model through the EMME program. Considering trucks and jeepneys via RORO, and long haul via conventional shipping, results showed that as the distance increases, the unit cost of transporting via RORO also increases. Results of the simulation show that transporting banana and palay via RORO remain to be more cost effective than moving them via long-haul shipping over short distances.

***Key words*:** RORO, SRNH, long haul

1. INTRODUCTION

The Philippines is an archipelago of approximately 7,107 islands. It has a long coastline that extends to 36,289 kilometers. Since time immemorial, the separation of the country into several islands has been an impediment to providing progress in the countryside. Inefficient transportation of goods from Luzon, through Visayas, to Mindanao and vice versa stemming from high cost of transportation and lack of integration of peripheral islands to urban economic nodes have become an obstruction to development, socioeconomic integration and growth of the maritime dependent country.

Initiatives of many countries all over the world to facilitate seamless movement of people and goods through intermodal transportation have led to tremendous economic development, resonating in the macro-economic level.

With the issuance of Executive Order 170 by President Gloria Macapagal-Arroyo in 2003, which defines the RORO transport policy, launched the development of the Strong Republic Nautical Highway (SRNH). SRNH, or Road RORO Terminal System (RRTS, as designated by EO 170, EO-170-A and EO-170-B), are network of port terminals all over the country, regardless of distance covered and linked by RORO vessels. The SRNH consists of three main highways: The Western Nautical Highway (red), The Central Nautical Highway (blue), and The Eastern Nautical Highway (orange), (see Figure 1). Currently, only the Western Nautical Highway is fully operational meaning it is the only route which has the complete facilities and vessels which could accommodate RORO transport.

Since the construction of the nautical highway system, areas were developed, the inter-island shipping industry was restructured, transportation costs were reduced, tourism was enhanced, and logistics operations and strategy of industries were changed. Arising from these are apparent economic gains that improve the overall performance of the Philippine economy.

This study looked at how the nautical highway system works (identified actors & modes of transportation in the system, reviewing policies, considering as well issues and concerns of the people, etc.), looked at options of regional travel and freight transport before and after the system is in place, determined its effects on logistics operations, applied necessary data and analytical tools that supported the hypothesis of improved overall logistics. The purpose for such is that the researchers have recognized the value of investing in transportation infrastructures, primarily to logistics operations for the economy. The findings of the study may invoke the crafting of more policies and focus of investments in transportation infrastructures like roads and bridges in the future

2. PROBLEM STATEMENT

"During the various conferences held in Mindanao in 2002, one of the persistent issues raised by the shippers was the high cost of transport from Mindanao to Manila. Among others, Roll-on/roll-off (RORO) shipping was proposed as a solution to the transport problem", Agriculture Business Week (July2009).

The Mindanao region is one of the top producing regions of agricultural crops like palay and banana. The 2GO Freight Company, under the Aboitiz & Company, ships these types of commodities directly from Cagayan De Oro to Manila via long-haul shipping which costs at an estimate of P38,564++ for perishable crops and P33,161++ for non-perishable crops, using a 20 foot container (February 2010 rates). Thus, shipping these types of goods via long-haul shipping from Mindanao to Manila is an impediment to shippers due to the high cost of transporting.

Because of the Philippine's geographic feature, the islands are not connected to each other, and the high cost of air shipping, the most viable mode of transporting these commodities from Mindanao to Manila is through the sea, however, due to the high cost of transporting these commodities and the lack of inter-island linkages inhibits the full potential of a transportation infrastructure network.

Figure 1. Strong Republic Nautical Highway (Western, Central and Eastern)
Source: Philippine Ports Authority (PPA), 2009

3. HYPOTHESIS

The researchers first hypothesized that the optimized route in commodity transport from Mindanao to Manila is through the Western Nautical Highway. Second, the Western Nautical Highway route, via RORO, offers a faster and a cheaper alternative to long haul shipping in the transportation of palay and banana.

4. SCOPE, LIMITATIONS, AND DELIMITATIONS

The scope of the study will focus on the movement of banana and palay using the RORO under the Strong Republic Nautical Highway (SRNH) and via conventional shipping (Long-Haul). Due to the vast scope of the study, the researchers limited their study on the following: they only interviewed Montenegro Shipping Lines, Inc. since this is the only private shipping company which offers complete RORO services along the Western Nautical Highway. The researchers based the price of shipping and schedule of trips of long haul via registered customer service center provided by Aboitiz–2Go company. The study is limited to the road and port networks under the Western Nautical Highway. The study is limited only to the inter-regional movement of goods and not on the intra-regional movements of goods. The study is limited to one-way movement of goods, example, Mindanao to Manila. Volume of agricultural commodity and other related data are only limited to the data provided by the Bureau of Agricultural Statistics. The rates are limited to the information provided by Montenegro Shipping Lines (RORO) and Aboitiz-2go (Long Haul). The research is limited to the cost of shipping the commodity via RORO where the cost is a function of distance with variables of the gas consumption, terminal fees at ports, toll fees and allowance of the drivers.

Also, the study delimits the assessment of the full impact of the SRNH because it is not yet fully operational. Not fully operational refers to having the necessary port facilities but lacking in RORO vessels. Only the Western Nautical Highway is fully operational.

5. FRAMEWORKS

5.1 Conceptual Framework

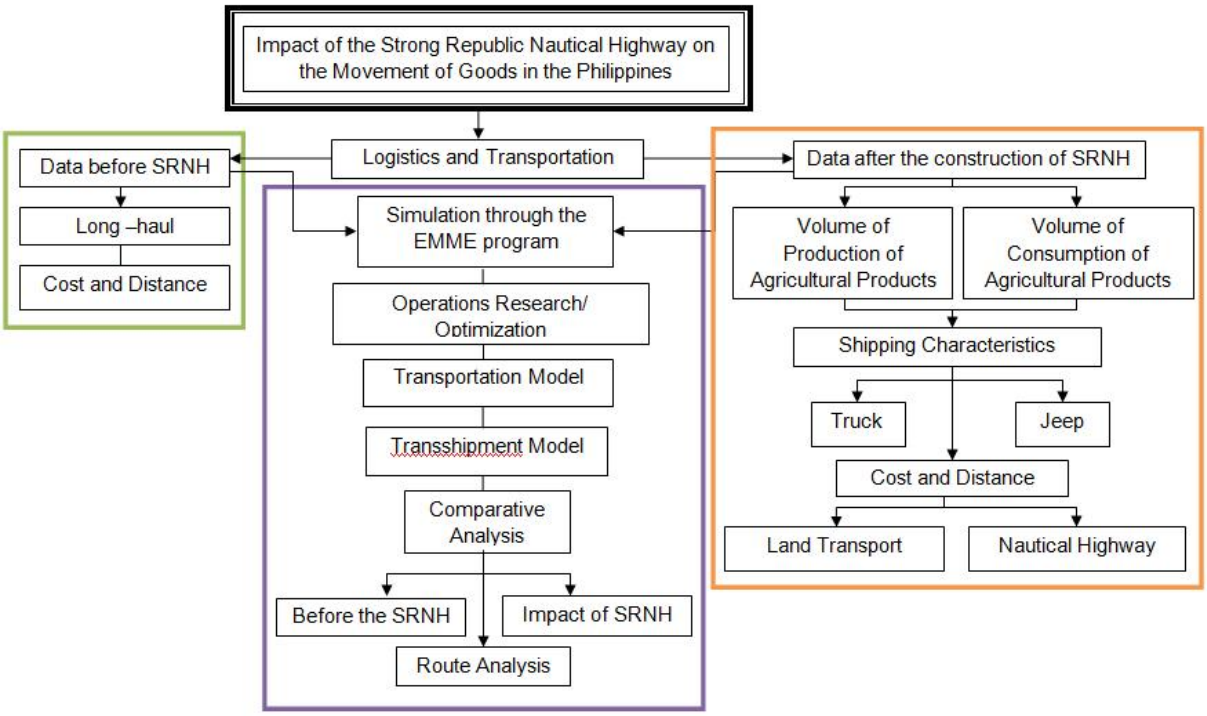

Figure 2. Conceptual Framework

The EMME program can aid the researcher in assessing the impact of the SRNH in the movement of goods in the Philippines by simulating the movement of goods using the factors of cost and distance of transportation. The EMME program can simulate the current state of the regional commodity flow (production and consumption) in various regions along the SRNH route by distributing the production to the consumption in every region.

5.2 Theoretical Framework

5.2.1 Intermodal Transport

Intermodal transport consists of three phases; 1) collection, 2) trunking and 3) distribution (see Figure 3). These three phases take place by using different networks and using at least two different transport systems. Waterborne and rail are typical transport modes for the trunkline phase in an intermodal transport chain, while the collection and distribution phase take place by road. Sometimes road-road transport is intermodal depending on how intermodal is defined.

The essence of using different transport modes is consolidation of all the phases of the trip. Combinations of transport modes can be consolidated to one trip thus making it easier to organize. Consolidation may lead to a better economy and possibly it may lead to the transport of goods at higher speeds.

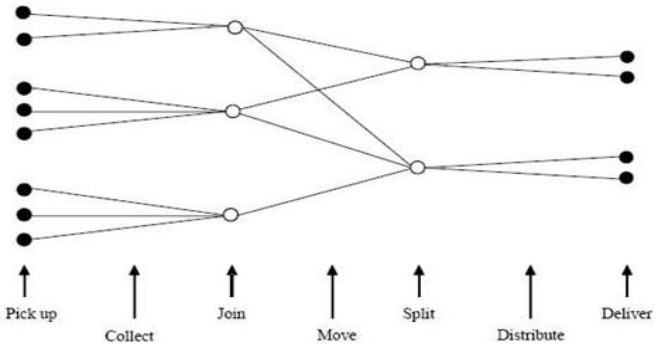

Figure 3. Components of Intermodal Transport
Source: Intermodal Transport & City Logistics Policies (Nemoto, Browne, Visser & Castro, 2006)

5.2.2 Operations Research

Operations research (OR) is used in the study to form mathematical models of complex engineering and management problems and how to analyses them to gain insight on how to establish possible solutions. It deals with decision problems. The mathematical model is a collection of variables and relationships needed to relate a decision based on the given data or constraints, for example, OR can determine the planning work shifts, choosing investments for available funds, or designing facilities for customer service etc. Mathematical representations are introduced to represent variables and relationships.

Decisions, Constraints and Objectives

There are three fundamental concerns in forming OR models: (a) decisions that the decision maker will make, (b) the constraints that will limit the decision choices, and (c) the objectives that makes some decisions preferred to others. Identifying these three fundamental concerns helps to clarify issues by giving a good direction/picture of what the problem/solution would look like.

Here are the assumed parameters in optimizing the problem. *Objective Functions*: Minimize unit cost of shipping goods trough the SRNH; Minimize time of shipping goods trough the SRNH. *Decision Variables*: Cost per volume, Time, Distance. Constraints: Schedule of the ship (arrival and departure) and no. of ship-calls per port, Type of commodity (agricultural, raw materials or industrial products), Volume capacity of the ship (long-haul/RORO) with respect to the volume of commodity being shipped, Supply capacity of the source, and Demand requirement of the destination.

5.2.3 Transportation Model

The transportation model is a special class of linear programs that deals with the shipment of a commodity from source to destination. The goal is to device a shipping schedule that will minimize the shipping cost and will satisfy supply and demand requirements. The steps in a transportation model are similar to those of the simplex method.

5.2.3 Transshipment Model

The transhipment model is a transportation model that considers the intermediate or transient nodes before reaching the final destination. It recognizes that it may be cheaper to ship through these nodes (transient nodes) than directly shipping from the source node to the supply node. Direct shipments are only allowed between the source and destination. This is perfect for intermodal shipping.

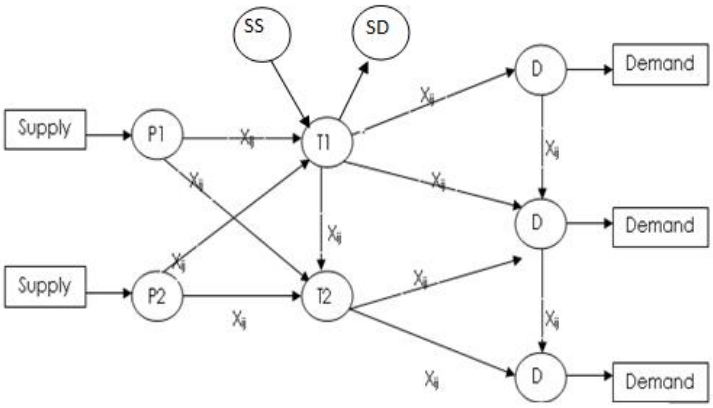

Figure 4. Transshipment Model
Source: Operations Research: An Introduction (Taha, 2007)

The transshipment model shown in Figure 4 is a transportation model that not only deals with the source and destination but also with the transient or intermediate nodes before reaching the final destination. The transient or intermediate nodes are points through which the commodity can be transshipped on their trip from a supply point to a demand point. Shipments are only allowed within the source and destination. It is assumed that the cost of shipping through the transient nodes is less than the cost of shipping it directly from its source to its destination. It is also assumed that the entire supply amount could pass any point on the network before ultimately reaching their destinations.

In the network shown, the nodes T1, T2, D1 and D2 acts as both source and destination because they have input and output arcs. They are called the transient nodes or transshipment nodes. The remaining nodes are purely supply (P1 and P2) and purely demand (D3) nodes.

The transshipment model can be converted into a regular transportation model with six sources (P1, P2, T1, T2, D1, D2) and five destinations (T1, T2, D1, D2, D3) with a dummy source (DS) and a dummy demand (DD). Capacity of the transshipment node should be adjusted in order to accommodate the largest original supply (total supply). Thus, buffer amounts are introduced to the transshipment nodes. We can now solve for the optimum route using the transportation model.

5.2.4 EMME

EMME is a computer-based transportation modeling program which can be used to simulate, assign, and distribute the movement of traffic in a given network. This program is a powerful tool in assisting the researchers in their study which can help them simulate the movement of agricultural goods along the Western Nautical Highway and further guide them in understanding the effect of the SRNH on the movement of goods in the Philippines.

The EMME Core offers the planner a complete and comprehensive set of tools for demand modelling, multimodal network modelling and analysis, and for the implementation of evaluation procedures. Figure 5 shows the EMME Core modelling framework.

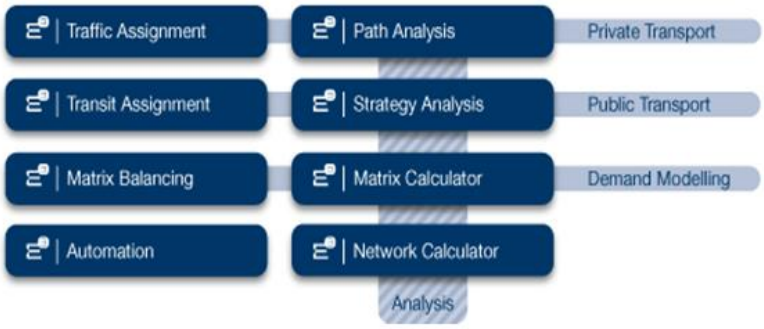

Figure 5. EMME Core modelling framework
Source: EMME transport modelling Website retrieved December 2009

6. RESEARCH METHODOLOGY

In determining the impact of the Strong Republic Nautical Highway, the current condition of transporting goods must be identified. This is the long-haul. The cost of shipping and the distance this covers must be identified. The current condition must be compared to the land transportation which are the trucks and the jeepneys in terms of the cost. The formulas for each segment in the network will be discussed later. Then the production and consumption zones must be identified.

In order to simulate the distribution of goods the no. of trips going in and out of the region must be identified. The consumption of every region was based on the population in each region. The average consumption of each person is multiplied to the population in the zone. Then the production is balanced in order to satisfy the consumption. The related data were obtained from the Bureau of Agricultural Statistics. The trips were identified by dividing the production and consumption volume by the capacity of the truck and the jeep.

Once the trips are identified, the simulation can now begin. Through the EMME program, the cost per trip can be obtained. The comparison between the long-haul cost and the land transportation can now take place.

The matrix of the production and the consumption of the goods were established based from the data obtained from the BAS. The production was averaged over the 10 year period while the consumption was based on the population in the regions that the researchers considered. The consumption per person was generalized and then multiplied to the population. The distribution of the total production was simulated in the EMME program.

7. RESULTS AND ANALYSIS

7.1 Balanced Trip matrix

The balanced trip matrix of both the production and consumption zones was used to simulate the movement of goods using the EMME program. The balanced matrix is in terms of the trips that are generated and attracted by both the production and consumption areas. Figures 6 and 7 shows the balanced truck trip matrix of palay for the network. The trips were identified from the consumption. The total consumption is divided by the capacity of the trucks. The output of the program is the trips distribution per zone. By multiplying the trips and the capacity of the mode used, the total volume of the commodity were identified.

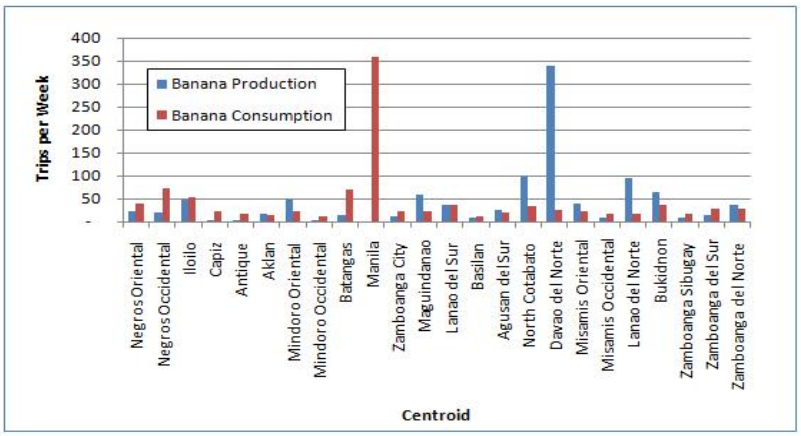

Figure 6. Balanced Trip Matrix for Banana (Truck Trips)

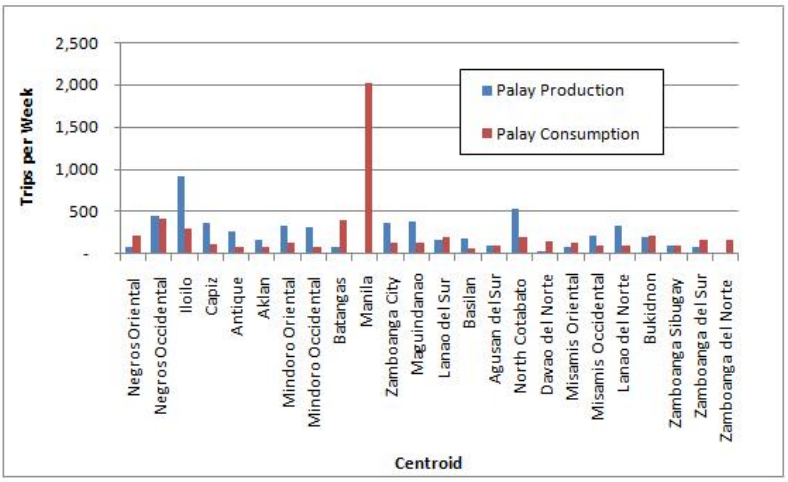

Figure 7. Balanced Trip Matrix for Palay (Truck Trips)

7.2 Volume Distribution and Movements of Goods

The volume of the goods that is distributed in the network depends on the production and the consumption of a specific centroid in the network. Before a region can supply or demand a commodity, the volume of production and the volume of consumption must be analyzed. The difference between the production and the consumption of a region can determine if the region will import or export a commodity. Table 1 shows the net production and consumption of the commodity. A negative sign indicates that the region demands that volume of commodity and that the flow of the commodity will be towards that region. The unit truck does not matter and the number trips can be multiplied to get the total volume. Table 1 was used as the matrix that was inputted in the EMME program so that the trips can be distributed.

Table 1. Difference between production and consumption (truck)

Name of centroid	Difference (Production - Consumption)			
	In terms of Truck		In terms of Jeep	
	Palay	Banana	Palay	Banana
Negros Oriental	-134	-16	-1002	-120
Negros Occidental	38	-55	287	-409
Iloilo	620	-5	4650	-41
Capiz	240	-18	1803	-132
Antique	176	-12	1320	-86
Aklan	84	2	633	17
Mindoro Oriental	211	24	1582	184
Mindoro Occidental	240	-12	1804	-91
Batangas	-315	-55	-2362	-414
Manila	-2022	-358	-15164	-2686
Zamboanga City	235	-12	1766	-88
Maguindanao	258	37	1937	281
Lanao del Sur	-26	2	-198	13
Basilan	109	-5	815	-38
Agusan del Sur	0	6	1	44
North Cotabato	334	64	2502	477
Davao del Norte	-119	314	-896	2353
Misamis Oriental	-54	17	-406	125
Misamis Occidental	122	-9	913	-65
Lanao del Norte	239	78	1795	588
Bukidnon	-13	27	-98	199
Zamboanga Sibugay	5	-9	39	-65
Zamboanga del Sur	-73	-14	-551	-102
Zamboanga del Norte	-156	7	-1169	56

7.3 Ports and Terminal Fee

The Philippine Ports Authority (PPA) provided the researchers with a complete list of government ports which is under the Western Nautical Highway. Figure 8 shows the government ports where RORO vessels can dock and undock. The researchers have also assumed that each port has a marshalling area where trucks can wait until they can get loaded.

The PPA has provided the researchers with basic information regarding the operation of RORO vessels, the ports where it operates and terminal fee. Table 2 shows the latest terminal feel charged to vehicle users which use the Western Nautical Highway Ports.

Table 2. Terminal Fees

Vehicle Type	Description	Terminal Fee (PhP)
1	Motorcyle, Scooter, Tricycle	65
2	Car, SUV, AUV, PUJ not more than 16 pax	129
3	Light Delivery Truck, van, pick-up	258
4	Stake Truck, heavy delivery truck, bus	516

Source: Philippine Ports Authority (PPA) December 2004

7.4 Land Transportation

Two types of land vehicle were used as a mode of transporting goods via the SRNH in this study. Each vehicle type has its own distinction and difference between one another in terms of its capacity, gas consumption, and practicality to be used for transportation.

Table 3 shows the land vehicle classification, capacity, average consumption, allowance given per vehicle, and their average loaded speed at National roads and Expressways. It shows that capacity is inversely proportional to gas consumption, because loaded vehicles tend to consume more gas.

Table 3. Land Vehicle Characteristics

Vehicle Type	Capacity (tons)	Average fuel Consumption (km/Liter)	Allowance of drivers (Peso/day)	Average loaded speed at National Road (kph)	Average loaded speed at Expressways (kph)
Jeepney	1.6	3 to 4	400	65	80
20ft Truck Container with prime mover	12	1 to 2	400	55	80

The operation costs of trucks were based on the following: its fuel consumption, allowance of the drivers, toll-fees, Terminal fee, and Fare rate. The petroleum type of the truck is diesel. Because the prices of diesoline products fluctuate, the researchers considered that the price of 1 liter of diesel will remain at P33.10 (February 2010 Rates) for the duration of the study. Allowance is given based on the distance and the duration of the trip.

The researchers did not consider delays in the transportation of goods because the study runs under normal conditions. Meaning, major causes for delays like weather, calamities, road constructions, major accidents, detours etc. will not be considered. Also the effect of minor delays likes flat tires, stops, minor accidents, traffic violation pose minor discrepancy to the time.

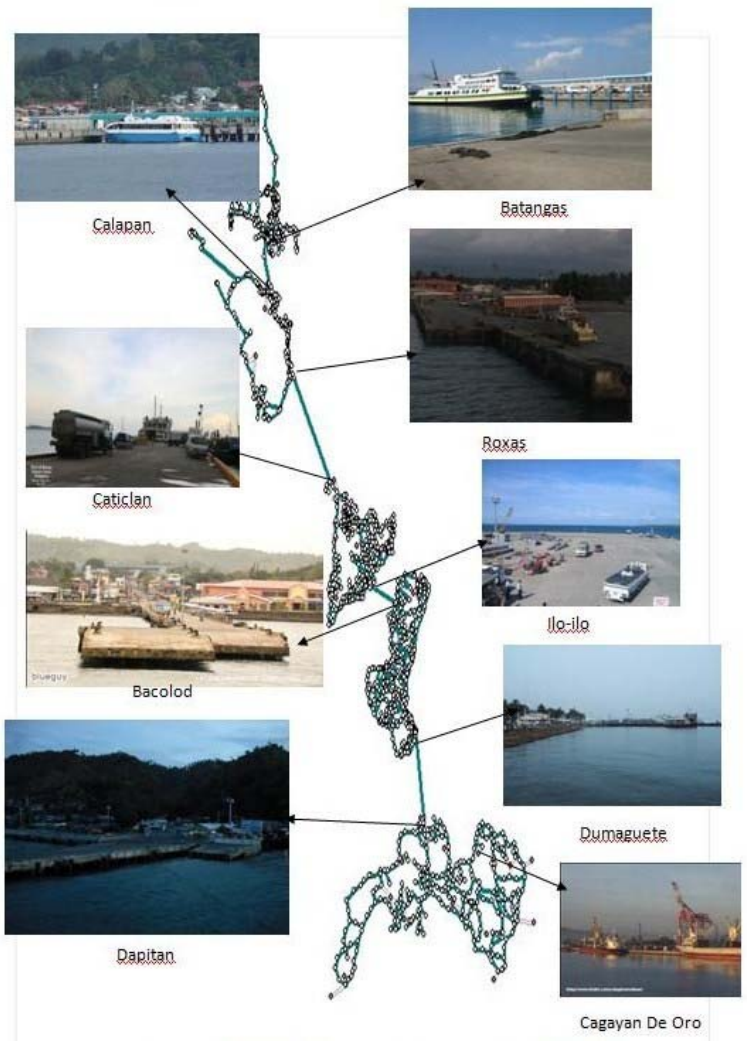

Figure 8. Base Network

7.5 Long Haul Transport

Agricultural goods can also be shipped using a 20ft container via Long Haul (conventional shipping). 2Go Company only offers long haul routes from Cagayan de Oro to Manila and from Bacolod to Manila.

Table 4 tabulates the estimated rates for long haul based on February 2010 rates from 2go Company using a 20ft container cargo. This charge includes taxes and fees. Also, the maximum capacity of a 20ft container cargo is 17 tons.

Table 4. Long Haul rates

Destination	Rate (Pesos)	
	Perishable Goods	Non-Perishable Goods
Bacolod - Manila	34,215 ++	33,161 ++
Cagayan de Oro - Manila	38,564 ++	33,161 ++

7.6 Roll-on Roll-off Transportation

Montenegro Shipping Lines, Inc. (MSLI) has provided the researchers with schedule of trip in each port along the region, vehicular rates, as well as information regarding their vessels.

Table 5 shows the breakdown of vehicular rates per trip, while equation 1 shows the calculation of fare for each trip along the Western Nautical Highway

Table 5. RORO rates

Category, L	Route	Rate per Nautical Mile (P/NM/M)	Distance in Nautical Mile (NM)
1-14 meters (Vehicle length)	Dapitan - Dumaguete	16	41
	Bacolod - Dumangas	16	16
	Caticlan - Roxas	14	46
	Calapan - Batangas	14	24

Source: Montenegro Shipping Lines, Inc., December 2009

$$Fare = L * R * D_p \quad (1)$$

where: L = Length of vehicle (meters)
R = Rate (PhP/Nautical Mile)
D_p = Distance between ports (Nautical Mile)

7.7 Cost Equations

Cost is one of the important factors considered in this study. This is one of the basis for which the researchers can assess if the SRNH is cost-effective compared to conventional shipping. The following equations satisfy the characteristics of the base network, but are dependent on the type of segment along the network and the type of transportation to be used.

Table 7. Cost Equations

For Vehicles that use the SRNH (shipping via RORO):		
Cost Incurred via Land	$C_{TL} = C_1 + C_4 + C_5 + C_6$	(2)
Cost Incurred via Sea	$C_{TS} = C_2 + C_3 + C_6$	(3)

Shipping via Long Haul (2go-Aboitiz Rate):		
Via Long Haul	$C_T = C_7$	(4)

where:

C_T = Total Cost	
C_1 = Gas cost in Peso (February 2010 rates) $C_1 = \left(\frac{Distance\ (km)}{Gas\ Consumption\ (^{km}/_{L})} * (Gas\ Price)\right)$ (5)	Gas consumption of trailer trucks: 2 km/L Gas consumption of jeepney: 4 km/L Gas Price: P33.10 (February 2010 rates)
C_2 = Fare (Boat Trip)	Cost is dependent on the distance between two ports and size of vehicle
C_3 = Terminal Fee	Rates are all the same on all SRNH ports but is dependent on vehicle type (refer to table 2)
C_4 = SLEX toll rate	February 2010 rates Jeepney: Php 87 Truck: Php 260
C_5 = STAR toll rate	February 2010 rates Jeepney: Php 55 Truck: Php 164
C_6 = Allowance of drivers $C_6 = \left(\frac{Distance\ (km)}{Speed\ i^{km}/_{hr}} * \frac{1\ day}{24\ hrs} * \frac{P400}{day}\right)$ (6)	Allowance of drivers at Php 400/day
C_7 = Long-Haul rate	January 2010 rates Based on Aboitiz-2go rates

All units are in Php (Philippine Peso)

These equations are then entered into the EMME program which resulted in the simulation of the most optimum route to transport the commodity.

7.8 Cost per ton versus Region

Figure 9 shows the logarithmic cost per trip vs region from Cagayan de Oro to Manila for truck and jeepney. It also shows in the Figure that the R-squared value for truck and jeepney is 0.9515 and 0.9412, respectively, which means that the equation is a good fit of the line to the data.

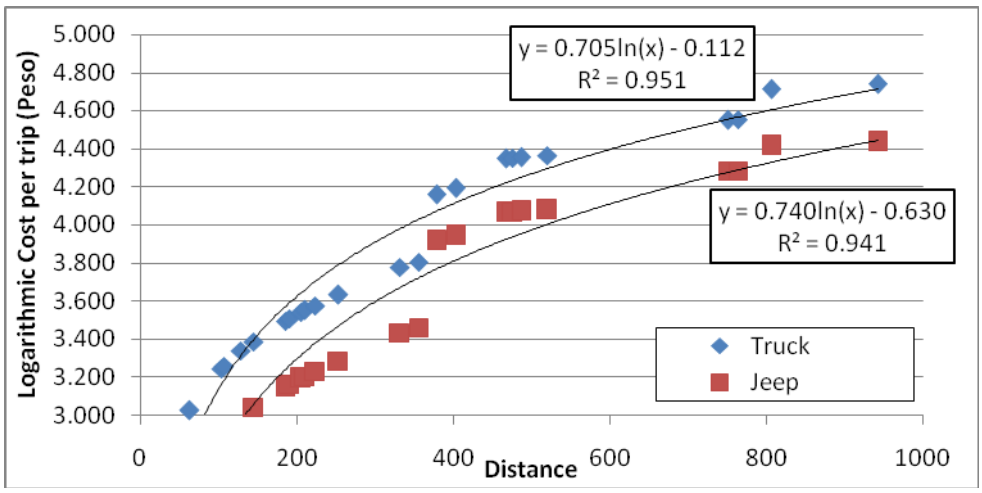

Figure 9 Logarithmic Cost per trip vs Region (CDO – Manila)

It can be seen in the graph that as the distance increases the cost also increases. This is consistent with the other comparison of the graphs discussed earlier. Also, the sudden rise in the slope of the cost of shipping via RORO can be seen in these graphs.

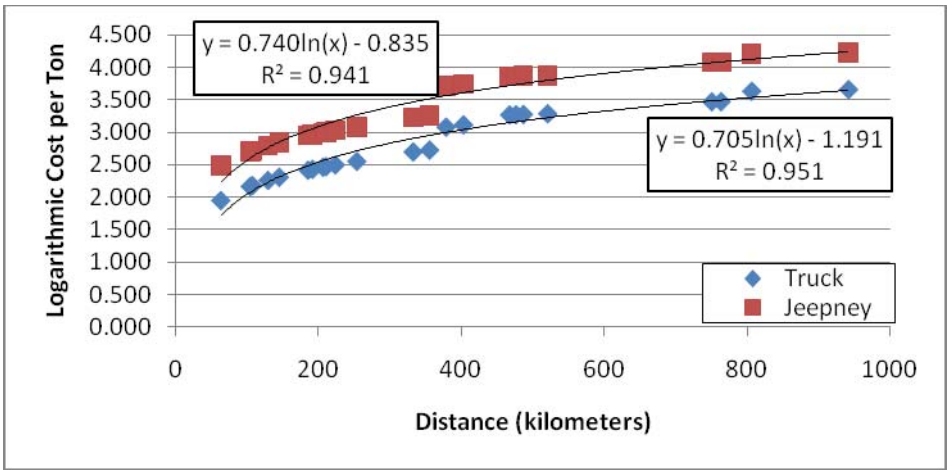

Figure 10 Logarithmic Cost per ton vs Region of truck (CDO – Manila)

Figure 10 now shows the logarithmic cost per ton vs region of truck and jeepney, from CDO to Manila. It also shows in the Figure that the R-squared value for truck and jeepney is 0.9515 and 0.9412, respectively, which means that the equation is a good fit of the line to the data.

Table 8 shows the following equation obtained from the logarithmic trendline from Figures 9 and 10:

Table 8. Equation from the logarithmic trend line

Cost per Trip	$y = 0.705\ln(x) - 0.112$	Truck	(7)
	$y = 0.7407\ln(x) - 0.630$	Jeep	(8)
Cost per Ton	$y = 0.705\ln(x) - 1.191$	Truck	(9)
	$y = 0.7407\ln(x) - 0.835$	Jeep	(10)

where: $y = a\ln(x) + b$

a = slope
b = intercept
x = distance (kilometers)
y = logarithmic cost (base 10)

Since the equation is based on a logarithmic function and the unit of x is in terms of distance, x cannot be equal to or less than zero (0). As the distance (value of x) increases, the logarithmic cost (value of y) also increases.

For example, considering Equations 7 and 8, if the distance (x) is equal to 763 kilometers, the actual cost per trip obtained from the logarithmic cost of truck and jeepney for the said distance is P36,898 and P19,276, respectively. From these results, it shows that it is more economical to ship via jeepney than truck, considering the cost per trip rate. Now considering Equations 9 and 10, applying a distance (x) of 763 kilometers, the actual cost per ton rate obtained for truck and jeepney for the same route is P3,076/ ton and P12,050/ton, respectively. It shows that it is more economical to ship via truck, considering the cost per ton rate.

Based on the results, Figure 9 shows that the truck has the highest cost per trip compared to jeepney, but Figure 10 shows that jeepney has a higher cost per ton rate than truck. Choosing for

the most economical route for CDO – MNL considering truck and jeepney, the researchers suggest that it is more economical to ship via truck for medium to large volume deliveries, and to ship via jeepney for small volume deliveries. Considering long-haul as another option, this mode of transport is the most economical mode to be used among the three for CDO-MNL route with large volume deliveries because it the actual cost per ton is P2238 per ton.

7.9 Research Cost and Actual Retail Cost per Kilogram of Commodity

The simulation of the movement of the goods generates transportation cost of shipping of the commodity. The cost of shipping the commodity is added to the farm gate cost and then compared to the actual retail cost of the commodity. Because of the data that the researches have gathered, the effect of the research cost did not have a significant impact in the total cost of the commodity. The research cost is only based on the gas consumption, gas and terminal fees. Other factors must be identified in determining the actual cost of a commodity.

8. CONCLUSION

Based on simulation runs using EMME, the researchers were able to identify the cost per trip of each mode and identify the most economical route to transport the commodity.

Considering the difference in the capacity of truck, jeepney, and long haul, the capacity of these vehicles bears a huge factor on what the shipper will use to transport the commodity. The truck and long haul has a larger capacity but it requires more money to operate it while for jeepney has a lower operating cost but its capacity to transport commodity is limited. In spite of a lower operating cost per trip incurred of operating a jeepney it would tend to cost the shipper more due to the number of trips to be made in order to satisfy the demand of a certain region. Thus, it is more viable to ship using another type of transport with a larger capacity. Although this would be the case, not every shipper could afford to ship using truck or long haul, thus shippers opt to ship using jeepney which is readily available to any small-sized and medium-sized shippers.

It also shows that as the distance increases the cost per ton and the cost per trip of transporting via RORO is also increasing caused by fuel costs, terminal fee, and fare rate of the RORO vessel. Thus, RORO transport is competitive to long haul shipping within one or two RORO links while long haul is more feasible to be used for long distance trips.

Concluding the whole study, the SRNH-Western Nautical Highway RORO ferry service itself does not achieve the reduction of transportation cost, but the shippers benefit on the structural change of the logistics system from large volume and few deliveries to medium-small volume and frequent deliveries.

In this case, door-to-door deliveries and/or shippers who have multiple drop-off areas in different islands may benefit using land-RORO mode even though it may use more than two RORO links because they can maximize the single trip of the vehicle. While for long-distance shipping (Mindanao to Manila), shipping via long haul is still a viable mode of transportation to be used.

After obtaining the results based on simulation runs, the researcher's hypothesis, that shipping via the SRNH route offers a faster and a cheaper alternative to long haul shipping in the transportation of goods, is not always applicable especially when the distance between two regions is more than two RORO links.

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REFERENCES

Alonzo, R., Rognstad G., Ashar, A., Navarro, A. (2007) The Road-RORO Terminal System: Bicol Mainland-Masbate-Cebu Connection.

Blanchard, B. S. (2004) Logistics Engineering and Management.

Federal Highway Administration U.S. Department of Transportation (2002) Transportation Infrastructure, Freight Services Sector and Economic Growth: A Synopsis. Freight Transportation, Improvements and the Economy.

Fricker, J. D., & Whitford, R. K. (2004) Fundamentals of Transportation Engineering-A Multimodal Systems Approach.

JICA & DOTC (2007) The Feasibility Study on the Development of Road RO-RO Terminal System for Mobility Enhancement in the Republic of the Philippines.

Kobune, K. (2008) Feasibility Assessment Of RoRo Transport System in the Philippines From the View Point of Inter-Regional Commodity Flow.

Lidasan, H. S., & Castro, J.T. (2009) Philippine Intermodal Logistics System and Policies. Logistics Conference. Dusit, Hotel, Makati, Metro Manila.

Millora, R. C. (1999) Analysis Of Intermodal Passenger Travel In The Philippines, The Case Of Batangas-Mindoro Route.

National Cooperative Highway Research Program Report (1991) NCHRP 342 Primer on Transportation, Productivity and Economic Development.

National Cooperative Highway Research Program Report (2007) NCHRP 570 Guidebook for Freight Policy, Planning, and Programming in Small- and Medium-Sized Metropolitan Areas.

Nemoto, T., Browne, M., Visser, J., & Castro, J.T. (2006) Intermodal Transport and City Logistics Policies.

Okada, H. (2007) The Feasibility Study on the Development of Road RO-RO Terminal System (RRTS) for Mobility Enhancement in the Republic of the Philippines.

Rardin, R. L. (1998) Optimization in Operations Research. Prentice-Hall International, Inc.

Ravindran, A., Rsdell, K. M., & Reklaitis, G. (2006) Engineering Optimization Methods and Applications, Wiley.

Taha, H. A. (2007) Operations Research - An Introduction. Pearson Prentice Hall.

The Ro-Ro Connection (2008-2009) Retrieved July 2009, from Agriculture Business Week: http://www.agribusinessweek.com/tag/roro.