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Application of International Freight Simultaneous Transportation Equilibrium Model to Sultanate of Oman

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Abstract

An implementation of the International Freight Simultaneous Transportation Equilibrium Model (IFSTEM) that developed in United Nations Economic and Social Commission for Western Asia (ESCWA), to the goods trade through the ports and lands of Sultanate of Oman is presented. Although some socio-economic variables, which are not available, were required for IFSTEM model calibration, some reasonable assumptions were made and it was good enough to draw the following main findings: the proposed alternative enhancement scenarios were four nested scenarios, *i.e.*, each scenario included the previous one plus an additional enhancement. These four enhancement scenarios were analyzed against and compared with scenario (0), *i.e.*, the reference "do nothing" scenario. The prediction results revealed that the estimated international trade flows (imports, exports and re-exports) for Oman were increased by more than 504% by 2040 compared to the present situation of the base year 2012. This increase would represent around 70% compared to the "do nothing" reference scenario by the year 2040 assuming that the average increase of international trade flows in the "do nothing" case would be around 4% annually during the analysis period from 2012 to 2040. The predictions of average total trip time and total cost per ton revealed an estimated decrease, compared to the reference scenario, by around 25% and 20% respectively. These results are internally consistent and represented reasonably significant improvements compared to the "do nothing" reference scenario.

Keywords

International Multimodal Multicommodity Network, Simultaneous Transportation Network Equilibrium Model, Integrated Transport

Network, Integrated Transport System, International Freight Transport, Exporters, Importers

1. Introduction

The prediction of multicommodity freight flows over a multimodal network has attracted much interest in the recent years. In contrast to urban transportation, where the prediction of passenger flows over multimodal networks has been studied extensively and many of the research results have been transferred to practice (Safwat and Walton [1], Safwat and Hasan [2], Safwat [3] and [4], Safwat and Magnanti [5], Hasan [6], Hasan and Al-Gadhi [7], Hasan and Safwat [8], Florian [9] and [10]), the study of freight flows at the national, regional, or international level, perhaps due to the inherent difficulties and complexities of such problems, received less attention. A good review of freight transport modeling may be found in Friez and Harker. Below is a brief review based on Guelat *et al.*

The first class of models that was well studied in the past for prediction of interregional freight flows is the *spatial price equilibrium model* and its variants. The model, stated initially by Samuelson [11] and extended by Takayama and Judge [12] [13] then by Florian and Los [14], Friesz, Tobin and Harker [15], has been used extensively for analyzing interregional commodity flows. This class of models determines simultaneously the flow between the producing and consuming regions as well as the selling and buying prices. The transportation network is usually modeled in a simplistic way (bipartite network) and these models rely to a large extent on the supply and demand functions of the producers and consumers respectively. The calibration of these functions is essential to the application of these models and the transportation costs are unit costs or may be functions of the flow on the network. There have been so far a few multicommodity applications of this class of models, with the majority of applications having been carried out in agricultural and energy sectors in an international or interregional setting. It is not this class of models which is the main topic of our study.

The second class of models which we consider are *freight network equilibrium models* which enable the prediction of multicommodity flows over a multimodal network, where the physical network is modeled at a level of detail appropriate for a nation or a large region, and represents the physical facilities with relatively little abstraction. The demand for the transportation services is exogenous and may originate from an input-output model, if one is available, or from other sources, such as observed demand or scaling of observed past demand (in our proposed model endogenous transportation demand will be considered). The choice of mode or subsets of modes used is exogenous and intermodal shipments are permitted. In this sense, these models may be integrated with econometric demand models as well. The emphasis is on network representation and the proper representation of congestion effects in a static model aimed to serve comparative studies or discrete time multiperiod analyses.

The first significant multimodal predictive freight network model was by Roberts [16] and later extended by Kresge and Roberts [17]. This model became known as the Harvard-Brookings model. Only the behavior of shippers was taken into account. Using constant unit costs, each shipper chooses the shortest path for movements from an origin to a destination. The amount moving between an origin-destination (O-D) pair being determined by a simple distribution submodel. The model resorted to a fairly simple "directed link" representation of the physical network and congestion effects were not considered. The model was applied to the transport network of Columbia.

Later, the Multi-State Transportation Corridor Model (McGinnis *et al.* [18], Jones and Sharp [19] and Sharp [20]) went a step further in representing an explicit multimodal network, but without any consideration of congestion. The first model that considers congestion effects and shipper-carrier interaction is that of Friesz *et al.* [21]. A review of shipper-carrier models, both sequential and simultaneous, is given by Friesz and Harker [22]. The first application of a model that considers congestion phenomena in this field is the Freight Network Equilibrium Model (FNEM) (Friesz *et al.* [23]). This is a sequential model which uses two network representations : an aggregate network that is perceived by the users, which serves to determine the carriers chosen by the shippers and then more detailed separate networks for each carrier, where commodities are transported by minimizing total cost. A generalization of the work of Friesz *et al.* [21] in which variable demand functions are considered in the shipper's submodels, is given by Harker and Friesz [24] and [25]. They combine the variable demand modeling approach of spatial equilibrium models with a detailed description of the behavior of shippers and carriers, in mathematical formulations that are yet to be tested in a practical application.

Guelat, *et al.* [26] developed a multimodal multiproduct network assignment model that does not consider shippers and carriers as distinct actors in the decision made for shipping freight. This level of aggregation which is appropriate for strategic planning of freight flows, where origins and destinations correspond to relatively large geographical areas, leads to the specification of supplies and demands for the products considered, which represent the services provided by all the individual shippers for the same product. Their model assumes that goods are shipped at minimum total generalized cost, which is particularly appropriate when certain products are captive to a mode, or a subset of modes, due to service availability or regulation. In other situations, as in our study, when modes compete for the shipment of products, generalized cost function components which reflect shippers' objective should be included. This generalized cost may be composed of costs, time delays or other relevant factors, keeping in mind that shippers, in this context, are aggregated by origins. The multimodal aspects of their model are accounted for in the network representation chosen and the multiproduct aspects are accounted for in the formulation of the predictive model and are taken advantage of in the solution procedure.

Safwat [27] describes in his dissertation an intercity transportation model, *i.e.*, a Simultaneous Transportation Equilibrium Model (STEM). An application of the STEM model to Egypt included both passenger and freight movement. The generation of trips in a region is incorporated via a specific non-linear functional form including transportation costs (see also Safwat and Magnanti [5]). Thus, Safwat represented producers' and consumers' behavior by this specific trip generation function, collapsing their decision-process into one known functional relationship. In practice, the STEM model was applied to many real-world transportation systems. The most recent applications were on the urban transportation network of Tyler, Texas, U.S.A. (Hasan and Safwat [8]) and of Riyadh, Saudi Arabia (Hasan and Al-Gadhi [7]). Earlier applications included the intercity passenger travel in Egypt (Safwat [3] and [4]) and the urban transportation network of Austin, Texas, U.S.A. (Safwat and Walton [1]). Moavenzadeh *et al.* [28] included an extended version of the STEM model as a central component of a comprehensive methodology for intercity transportation planning in Egypt [29]. This methodology has been used in several case studies involving multimodal transportation of passengers and freight in Egypt.

Safwat and Hasan [30] further adapted the STEM to International Freight STEM (*i.e.*, IFSTEM) and implemented it to the Integrated Transport System in the Arab Mashreq (ITSAM) through United Nations Economic and Social Commission for Western Asia (UN-ESCWA).

Hasan [31] implemented and adapted the IFSTEM methodology to the international trade flows through Lebanon, Syria and Jordan. Throughout these applications, STEM and IFSTEM predictions consistently outperformed the predictions produced by applying the traditional sequential transport planning approach used worldwide by international consultants.

More recently, Mathisena and Hanssena [32] give a good academic literature on intermodal freight transport. First, they examined the historical development of academic research on intermodal freight transport. Second, they identified the seminal works on the topic.

Duan *et al.* [33] demonstrate the effect of recognizing heterogeneity in values of time (VOT) on the design of a hub network for freight transportation. By taking the VOT distribution into account, we emphasize shippers' broader logistical, social and economic situation in the network design, and are not limited to commodity types.

The IFSTEM-Oman adapted in this paper is essentially based on the above mentioned developments, adaptations and implementations. That is, the IFSTEM-Oman is a simultaneous trip generation, trip distribution, modal split and traffic assignment model that most appropriately illustrates the behavior of exporters and importers of different commodities over the international multi-modal network for Oman.

The remainder of this article is structured as follows: In Section 2, we describe the international trade flows prediction model for Oman (IFSTEM-Oman Model); Then, in Section 3, IFSTEM-Oman model application assumptions are presented before predicted international trade flows, times and costs: application results and analysis are presented in Section 4; Finally, conclusions are presented in Section 5.

2. The International Trade Flows Prediction Model for Oman (IFSTEM-Oman Model)

Hasan [31] and Safwat and Hasan [30] described in details the basic functions and assumptions of the International Freight Simultaneous Transport Equilibrium Model (IFSTEM).

The IFSTEM Model may be briefly described as follows:

$$S_i^r = \max\left\{0, \ln \sum_{j \in D_i^r} \exp\left(-\theta_i^r u_{ij}^r + A_j^r\right)\right\}, \ \forall i \in I^r$$

$$G_i^r = \alpha^r S_i^r + E_i^r, \ \forall i \in I^r$$

$$T_{ij}^r = \begin{cases} G_i^r \dfrac{\exp\left(-\theta_i^r u_{ij}^r + A_j^r\right)}{\sum_{k \in D_i^r} \exp\left(-\theta_i^r u_{ik}^r + A_k^r\right)} & \text{if } imc \geq 0 \\ 0 & \text{otherwise} \end{cases}, \ \forall ij \in R^r$$

$$C_p^r \begin{cases} = u_{ij}^r & \text{if } H_p^r > 0 \\ \geq u_{ij}^r & \text{if } H_p^r = 0 \end{cases}, \ \forall p \in P_{ij}^r, ij \in R^r$$

$$C_p^r = \sum_{a \in A^r} \delta_{ap}^r C_a^r\left(F_a^r\right), \ \forall p \in P_{ij}^r, ij \in R$$

$$\delta_{ap}^r = \begin{cases} 1 & \text{if link a belongs to path } p \\ 0 & \text{otherwise} \end{cases}, \ \forall p \in P_{ij}^r, ij \in R^r$$

where

C = Set of all commodity types;

M = Set of all mode types;

O = Set of all ALO (Administrative and Logistics Opeerations) types;

(N, A) = A multimodal multi-commodity network consisting of a set of N nodes and a set of A links where: $N = \bigcup_{r \in C} r \in C$ and $A = \bigcup_{r \in C} A^r$;

I = Set of origin (export) nodes $I = \bigcup_r I^r$ and $N^r \supseteq I^r$;

i = An origin (export) node in the set I;

r = The commodity type;

D_i^r = Set of destination (import) nodes that are feasible for importing commodity r from origin i;

j = A destination (import) node in the set D_i^r;

p = A simple (*i.e.*, no node repeated) multimodal path (*i.e.*, it may include a combination of links with different modes);

R^r = Set of origin-destination pairs (ij) for commodity r;

R = Set of all origin-destination pairs (ij) in the system, where $R = \bigcup R^r$;

$P_{ij}^{m(r)}$ = Set of simple paths that can be used to transport commodity r ^{r} from origin i to destination j using only $m(r)$ modes of transport;

P^r = Set of simple paths in the network (N^r, A^r), *i.e.*, $\left(P^r = \bigcup_{ij \in R^r} P_{ij}^{m(r)}\right)$;

a = A link in the set A. Each link is identified by (k,l,q), *i.e.*, the link connects node k to node l by mode/operation q;

A_j^r = a composite measure of the effect that the socioeconomic variables, which are exogenous to transport system, have on the number of tons of commodity r imported at destination j;

S_i^r = accessibility of exporter of commodity r at origin i;

G_i^r = the total number of tons of commodity r exported from origin i;

E_i^r = a composite measure of the effect that the socioeconomic variables, which are exogenous to the transport system, have on the number of tons of commodity r exported from origin i;

T_{ij}^r = the number of tons of commodity r exported from origin i to a destination j;

u_{ij}^r = the "perceived" delivery cost (price) of the commodity r exported from origin i and imported to destination j;

$imc = SP_j^r - u_{ij}^r - MP_j^r \geq 0$ = the import criteria;

SP_j^r = the average selling price of commodity r that an importer at destination j knew it;

MP_j^r = a margin profit of commodity r that an importer specified it;

H_p^r = the flow of commodity r on multimodal path p and the link-path incidence relationships are given by $F_a^r = \sum_{p \in P^r} \delta_{ap}^r H_p^r, \forall a \in A^r$;

C_p^r = the total perceived delivery cost for commodity r from export origin node i to import destination node j on any multimodal path p, which is the sum of the perceived costs on the links, $C_a^r\left(F_a^r\right)$, that comprise that multimodal path.

2.1. Equivalent Optimization Problem (EOP) for IFSTEM

The IFSTEM model can be formulated as the following EOP for each commodity $r \in C$:

$$\text{Minimize } Z(S,T,H) = \sum_{i \in I^r} \frac{1}{\theta_i^r}\left[\frac{\alpha^r}{2}\left(S_i^r\right)^2 + \alpha^r S_i^r - \left(\alpha^r S_i^r + E_i^r\right)\ln\left(\alpha^r S_i^r + E_i^r\right)\right]$$
$$+ \sum_{i \in I^r} \frac{1}{\theta_i^r}\left[\sum_{j \in D^r}\left[T_{ij}^r \ln T_{ij}^r - A_j^r T_{ij}^r - T_{ij}^r\right]\right] + \sum_{a \in A^r} \int_0^{F_a^r} C_a^r(w)\,\mathrm{d}w$$

Subject to:

$$\sum_{j\in D_i^r} T_{ij}^r = \alpha^t S_i^r + S_i^r, \quad \forall i \in I^r$$

$$\sum_{p\in P_{ij}^r} H_p^r = T_{ij}^r, \quad \forall ij \in R$$

$$S_i^r \geq 0, \quad \forall i \in I^r$$

$$T_{ij}^r \geq 0, \quad \forall ij \in R^r$$

$$H_p^r \geq 0, \quad \forall p \in p^r$$

where

$$F_a^r = \sum_p \delta_{ap}^r H_P^R, \quad \forall p \in p^r.$$

2.2. The Solution Procedure for EOP

We need an efficient solution procedure for the EOP that is guaranteed to converge to an existing and unique equilibrium. Safwat and Brademeyer [34] developed a globally convergent efficient algorithm called the Logit Distribution of Trips (LDT) algorithm for predicting equilibrium on the STEM model. We adapted this algorithm to solve our IFSTEM. The algorithm belongs essentially to the class of feasible-direction methods and is known to be globally convergent. For each commodity, at any given iteration, k, the method involves three main steps:

1) determines a direction for improvement, d^k;

2) Determines an optimum step size, λ^k, along that direction;

3) Updates the current solution, X^k, $X^{k+1} = X^k + \lambda^k d^k$ where the vector X^k is defined by $X^k = \left(S^k, T^k, F^k\right)$.

As mentioned in the network representation of Safwat and Hasan (2004) and Hasan (2009), each O-D pair for a given commodity will have its own network, therefore the algorithm will deal with each O-D pair network separately and then updates its flows to the commodity network level. The algorithm can be summarized as follows:

Solution Algorithm:

Step 0: ***Initialization.***

Perform all-or-nothing assignment based on $C_a = C_a(0), \in a \in A$ (*i.e.*, free flow cost). This yield $X^1 = \left(S^1, T^1, F^1\right)$. Set. $k = 1$.

Step 1: ***Cost update.***

Set $C_a^k = C_a\left(F_a^k\right), \forall a \in A$.

Step 2: ***Direction finding.***

Compute the costs on the shortest paths $u_{ij}^k, \forall ij \in R$ based on C_a^k. Find $d^k = Y^k - X^k$ where the vector $Y^k = \left(L^k, Q^k, V^k\right)$ is given by

$$L_i^k = \max\left\{0, \ln \sum_{j\in D_i} \exp\left(-\theta_i u_{ij}^k + A_j\right)\right\}, \quad \forall i \in I$$

$$Q_{ij}^k = \begin{cases} \dfrac{\left(\alpha L_i^k + E_i\right)\exp\left(-\theta_i u_{ij}^k + A_j\right)}{\sum\limits_{l \in D_i} \exp\left(-\theta_i u_{il}^k + A_l^k\right)} & \text{if } imc = SP_j - u_{ij}^k - MP_j \geq 0 \\ 0 & \text{otherwise} \end{cases}, \quad \forall ij \in R$$

$$V_a^k = \sum_{ij \in R} \sum_{p \in P_{ij}} \delta_p B_p^k, \quad \forall a \in A$$

where $B_p^k = \begin{cases} Q_{ij}^k & \text{if } p = p^* \in P_{ij} \\ 0 & \text{otherwise} \end{cases}, \forall p \in P_{ij}, \forall ij \in R$ and p^* is the shortest path between the given O-D pair. Then the feasible direction at iteration k is the vector d^k with the following components:

$$d_i^k = L_i^k - S_i^k, \quad \forall i \in I$$

$$d_{ij}^k = Q_{ij}^k - T_{ij}^k, \quad \forall ij \in R$$

$$d_a^k = V_a^k - F_a^k, \quad \forall a \in A$$

Step 3: ***Line search.***

Find λ^k that solve

$$\sum_{i \in I} \frac{\alpha}{\theta_i}\left[\left(S_i^k + \lambda d_i^k\right) - \ln\left(\left(S_i^k + \lambda d_i^k\right) + E_i\right)\right] d_i^k + \sum_{ij \in R} \frac{1}{\theta_i}\left[\ln\left(T_{ij}^k + \lambda d_{ij}^k\right) - A_j\right] d_{ij}^k$$
$$+ \sum_{a \in A} C_a\left(F_a^k + \lambda d_a^k\right) d_a^k = 0$$

Step 4: ***Move.***

Set.

$$S_i^{k+1} = S_i^k + \lambda^k d_i^k, \quad \forall i \in I$$

$$T_{ij}^{k+1} = T_{ij}^k + \lambda^k d_{ij}^k, \quad \forall ij \in R$$

$$F_a^{k+1} = F_a^k + \lambda^k d_a^k, \quad \forall a \in A$$

Step 5: ***Convergence test.***

If a convergence criterion is met, stop (the current solution $\left\{S_i^{k+1}, T_{ij}^{k+1}, F_a^{k+1}\right\}$ is the set of equilibrium flow patterns); otherwise, set $k = k + 1$ and go to Step 1.

A computer code in C++ was developed to create the multimodal network representation requirements and solve the above Algorithm.

3. IFSTEM-Oman Model Application Assumptions

3.1. Application Assumptions for Demand Models

As can be seen from the description of the IFSTEM Model, it involves two demand models. These are trip generation and trip distribution models. In a typical application of the IFSTEM Model, these demand models would have been calibrated using available socio-economic and transport and logistics cost data. However, because of data limitation on the availability of socio-economic and transport and logistics cost variables, in this application of the IFSTEM-Oman

Model, we could not perform typical calibration of these demand models.

Instead, however, we assumed the following assumptions to "calibrate" the trip generation and trip distribution models within the IFSTEM-Oman Model. First, we invoked the following assumptions to estimate the exogenous variables E_i for each origin i from the equation

$$E_i = \sum_{l=1}^{L} \alpha_l q_l \left(E_{li}\right)$$

1) $l = 1$;
2) $q_l\left(E_{li}\right) = E_{1i} = G_i^o$ (Observed trip generation at origin i);
3) $\alpha_1 = 0.40$ for all origins.

Hence

$$E_i^o = 0.40 G_i^o, \quad \forall i \in I$$

That is, the socio-economic variables, which are exogenous to the transport and logistics system, are assumed to account for 40% of the international trade flows that are exported from that origin.

For the attractiveness measure in the trip distribution model,

$$A_j = \sum_{w=1}^{W} \theta_{iw} g_w \left(A_{wj}\right)$$

We assumed that

$$A_{ij} = \ln T_{ij}^o, \quad \forall ij \in R$$

By this assumption each destination has different attractiveness for different origins. We then assumed that this attractiveness composite measure is the exogenous variable in the exporter observed utility function. That is,

$$V_{ij} = -\theta_i u_{ij} + A_{ij}$$

We further assumed that the exporter at origin i is influenced only by this attractiveness measure and that he would not consider the delivery cost u_{ij} to be a major factor in his choice of the destination.

Hence, the accessibility measure for this behavior will be

$$S_i^o = \ln \sum_{j \in D_i} \exp\left(-\theta_i u_{ij} + A_{ij}\right), \quad \forall i \in I$$

$$S_i^o = \ln \sum_{j \in D_i} \exp\left(\ln\left(T_{ij}^o\right)\right), \quad \forall i \in I$$

$$S_i^o = \ln G_i^o, \quad \forall i \in I$$

And the trip generation model will be specified as follows:

$$G_i^o = \alpha_i S_i^o + E_i^0, \quad \forall i \in I$$

$$G_i^o = \alpha_i \ln\left(G_i^o\right) + 0.40 G_i^0, \quad \forall i \in I$$

Now we can estimate $\alpha_i, \forall i \in I$ from the observed trip generation as follows:

$$\alpha_i = \frac{0.6 G_i^o}{\ln\left(G_i^o\right)}, \quad \forall i \in I$$

We then estimated the parameters $\theta_i^r = \theta^r$ for all origins of commodity r by solving the IFSTEM-Oman Model for different values for θ^r until we obtain the values θ^r that satisfy the following condition:

$$\frac{\sum_{i\in I} G_i^o}{\sum_{i\in I} G_i^p} \approx 1.60 \quad \text{for each commodity}$$

where G_i^p is the predicted trip generation for origin i for year 2012. This value of θ^r will keep the effect of transport and logistics system (supply), as measured by the delivery cost u_{ij}, on the predicted trip generated from origin i to be 60% on average less than the observed trip generation.

This is consistent with the earlier assumption that 40% of trip generation is influenced by socioeconomic factors, which implies that 60% is influenced by transport and logistics cost factors.

3.2. IFSTEM-Oman Model Supply Side Assumptions

The supply side of IFSTEM-Oman Model is represented by a set of link cost functions for different modes and operations. We assumed the following link cost function

$$C_a(F_a) = (c + vt)F_a$$

where

F_a = number of tons on link a;

$C_a(F_a)$ = cost of F_a tons in USD;

c = cost per ton in USD;

t = time in days;

v = the value of time per ton per day.

Based on interviews with freight forwarders, we estimated the values of time (see Duan *et al.* [33]) to be as follows:

For exports 3.5 USD/Tone/Day, for imports 5 USD/Tone/Day, and for Re-exports 7.5 USD/Tone/Day.

3.3. Input Data for IFSTEM-Oman Model and Application Assumptions

3.3.1. Major Seaports and Land Border Points

According to the available statistics for imports, exports and re-exports for Oman during the base year of 2012, the international trade volumes (available for imports, exports and re-exports) at three major seaports and two major land border points represented around 74% of the total weight in tons of Omani exports, imports and re-exports and around 90% of the total value of these observed international trade statistics for Oman. Hence, in this application we considered these major five points of entry/exit of international trade to/from Oman. These are three major seaports, namely Mina Sultan Qaboos (at Muscat), Mina Sohar and Mina Salalah (see Figure 1 and two major land border points, namely Al Wajajah and Wadi Jizzi. From these five points we selected the five commodities of the highest volumes of trade with Oman.

Figure 1. Oman major seaports.

3.3.2. Observed International Trade Data for 2012

We obtained the following Import, Export and Re-Export Data for 2012 from the Omani National Centre for Statistics:

1) Commodity H.S Code (4 Digits);
2) Commodity Type;
3) Point of Entry;
4) Country of Export;
5) Observed Flows (in Kilogram and in Value of Omani Rial (OR)).

3.3.3. Estimated Documents, Times and Costs for International Trade for 2012

We obtained the following estimates of documents, times and costs of a typical 20-ft container for exports and imports, from the World Bank (WB) Report 2013 on Trading Across Borders (*i.e.*, estimates for the year 2012) for Oman and UAE:

1) Documents to Export (number);
2) Time to Export (days);
3) Cost to Export (USD per 20-ft container);
4) Documents to Import (number);
5) Time to Import (days);
6) Cost to Import (USD per 20-ft container).

We then assumed that the estimates for re-exports of Documents, Times, and Costs are the same as those estimated for Exports according to the WB report indicated above (see Table A1-1 and Table A1-2 in Appendix 1). We estimated the Import, Export and Re-Export Times and Costs for Inland Transport and Handling inside Oman and between Oman and the neighboring land connected

Arab countries, based on the WB Trading Across Borders Report 2013 (see Table A1-3 and Table A1-4 in Appendix 1).

3.3.4. Estimated International Maritime Transport Times and Costs for 2012

We obtained estimates for the International Maritime Transport Times (in days) and Costs (in USD per 20-ft container) for 2012 for Mina Sultan Qaboos from an International Freight Forwarder in Oman. We then assumed that these estimates are the same for Mina Sohar and Mina Salalah simply for lack of data and/or reliable estimates (see TableA1-5 in Appendix 1).

We further assumed that the commodities that go through the land border points Wadi Jizzi or Al Wajajah and not exported or imported from/to UAE, Saudi Arabia, Qatar, Bahrain, Kuwait, Jordan, Syria, and Iraq, will exit/enter from/to Jabil Ali Port in the UAE and their International Maritime Transport Times and Costs to/from other countries worldwide, from/to Jebel Ali Port are 20% less than the estimated values from/to Mina Sultan Qaboos.

All other commodities that go through the land border points Wadi Jizzi or Al Wajajah and exported or imported from/to UAE, Saudi Arabia, Qatar, Bahrain, Kuwait, Jordan, Syria, and Iraq are assumed to use only land transportation.

3.3.5. Other Application Assumptions

Mainly because of lack of appropriate detailed data and actual estimates from the field, we have invoked the previous assumptions and approximate estimates as well as the following general assumptions:

1) All 20-ft containers carry 10 tons per TEU (10000 KG), as assumed by WB reports.

2) All Points of Entry/Exit in Oman have the same procedures, costs, and times.

3) All Commodities have the same procedures, costs, and times at any Entry/Exit point.

4) Transit and Transhipment trade for Oman are excluded (for lack of data).

3.3.6. Alternative Enhancement Scenarios

To achieve the main objectives, our focus has been on undertaking effective and efficient actions with particular focus on significantly improving procedures, times and costs of international trade processes and transactions across Omani ports. In view of the above and the estimates of documents, times and costs for Oman imports and exports as indicated in the WB Trading Across Borders country report 2013, we proposed the first two Scenarios 1 and 2 involving reductions in number of documents and their associated costs as well as port terminal handing times, as indicated in paragraph 5 below.

Considering that an important objective of enhancing Omani ports is to attract major shipping lines to Omani ports. This would contribute significantly to reducing international maritime transport times and costs, and consequently total international trade trip times and costs per ton. The total volumes of international trade with Oman would be expected to increase significantly as well. Hence, we proposed Scenarios 3 and 4 that involve reducing international maritime transport times and costs by 20% and 40% respectively. Scenarios 3 and 4 are also inclusive of Scenarios 1 and 2, as indicated in paragraph 5 below.

Based on the estimated GDP growth rate for 2013 (which was approximately 4%) we assumed that the average annual growth rate for prediction purposes in our analysis is 4% annually during the analysis period from 2012 through 2040.

For each scenario we predicted the expected increase in international trade flows of imports, exports and re-exports (in tons), the expected decrease in average total trip time (in days) and the expected decrease in total cost per ton (in USD). The predictions are estimated for the years following the completion of implementation of the alternative enhancement scenarios until the target year of 2040.

Based on the above mentioned assumptions, the description of the five scenarios considered in the analysis are as follows:

- **Scenario 0 (2012-2040)**

  The reference scenario "do nothing" and its prediction to the target year 2040.
- **Scenario 1 (2015-2040)**

  Reduce No. of Documents from 8 to 4 as of the year 2015.
- **Scenario 2 (2016-2040)**

  Scenario 1 plus Reduce Ports & Terminal Handling Time from 3 days for export and 2 days for import to 1 day for each as of the year 2016.
- **Scenario 3 (2017-2040)**

  Scenario 1&2 plus Reduce International Maritime Transport Times and Costs for Oman by 20% as of the year 2017.
- **Scenario 4 (2018-2040)**

  Scenario 1&2 plus Reduce International Maritime Transport Times and Costs for Oman by 40% as of year 2018.

4. Predicted International Trade Flows, Times and Costs: Application Results and Analysis

In this section we summarize and analyze the results of the predicted international trade flows, times and costs of imports, exports and re-exports for Oman for all five alternative scenarios (*i.e.*, the reference scenario (Scenario 0) and the four alternative enhancement Scenarios 1, 2, 3 and 4). The Appendix includes Tables A2-1-A2-3 that show the results of the IFSTEM-Oman Model predictions. The following paragraphs summarize the analysis of these international trade flows, times and costs results for Oman from the base year of 2012 through the target year of 2040.

4.1. The IFSTEM-Oman Model Application

Based on the assumptions invoked in Section 3 above, the IFSTEM-Oman Model was first used to replicate the current situation (*i.e.*, the reference scenario (0) for base year 2012). The IFSTEM-Oman Model was applied to the 5 entry/exit points of Oman (*i.e.*, 3 seaports and 2 land border points as indicated in section 3) using the 5 highest volume commodities crossing these points (see **Table A1-6** in **Appendix 1**). The observed international trade flows of imports, exports and re-exports for the selected 5 commodities at these 5 entry/exit points was 811,881 tons.

The Import, Export and Re-Export Data for 2012 obtained from the Omani National Center for Statistics showed that there are 1128 commodities at the five points of entry/exit used in the analysis. The observed flows (volumes) for these 1128 commodities in 2012 were 27,338,746 tons and for all commodities crossing all points of entry or exit in Oman were 37,112,001 tons.

We then expanded the results of the IFSTEM-Oman Model to all exports, imports, and re-exports for Oman by multiplying the model results by the following expansion factor

$$\frac{37112001}{811881} = 45.71113.$$

This simple expansion factor is reasonable and consistent in this particular application of the model since the procedures, times and costs across commodities and entry/exit points in Oman were assumed to be equal. If and when the estimated and collected input data would involve variations among commodities and entry/exit points in Oman, the IFSTEM-Oman Model can then be easily applied to all commodities and all entry/exit points without the need to use an expansion factor.

4.2. Growth Rates of Future International Trade Flows

Based on the assumed average annual growth rate of 4%, the predicted international trade flows for any future year 2012 + t up to the target year 2040 are computed as follows:

Predicted International Trade Flows for any future year 2012 + t = (Observed or Estimated International Trade Flows for year 2012) × $(1.04)^t$.

For IFSTEM-Oman Model application, the annual growth rate for the socio-economic variables E_i and A_{ij} are computed as follows:

E_i For year 2012 + t = (E_i for year 2012) × $(1.04)^t$;

A_{ij} For year 2012 + t = (A_{ij} for year 2012) × $(1.04)^t$.

For example, the prediction for 2040 will use

E_i For year 2040 = (E_i for year 2012) × $(1.04)^{28}$;

A_{ij} For year 2040 = (A_{ij} for year 2012) × $(1.04)^{28}$.

4.3. Predicted International Trade Flows for Oman (2012-2040)

Table A2-1 in the **Appendix 2** shows the results of the predicted international trade flows for all exports, imports, and re-exports for Oman for the reference scenario and the proposed four enhancement scenarios indicated in Section 4 above, for all the years of the analysis period from 2012 through 2040. As indicated in **Table A2-1** Scenario 1 is assumed to be implemented in 2015, Scenario

2 in 2016, Scenario 3 in 2017, and Scenario 4 in 2018.

Below are Figures 2-4 that show the predicted international trade flow results of Table A2-1 in graphic formats easy to visualize and analyze. The prediction results of the IFSTEM-Oman Model as depicted in Table A2-1 and Figures 2-4 are essentially logical, internally consistent and reasonable. These predictions are satisfactory for the purposes of analysis in this paper, given the limited input data and estimates for this application. As indicated above, if and when more detailed data and estimates become available, the model is flexible, and appropriate to produce more detailed and refined results accordingly.

In all cases, various international researchers and practitioners including the Authors have already established that the IFSTEM simultaneous transportation equilibrium models, such as the model adopted in this Paper, are able to produce better results than other commonly used models and analysis techniques worldwide such as trend analysis and the sequential traditional transport planning models when applied to similar situation of input data and estimates. This is due to various distinctive features of the simultaneous IFSTEM model mainly its ability to predict increases in total international trade flows within the model, and its internal consistency of predictions of flows and costs, unlike the sequential models. The references cited in the second progress report of the Paper clearly demonstrated these distinctive advantages of IFSTEM.

Figure 2 shows the predicted high trends and rates of increase of international trade flows during the analysis period for the 4 alternative enhancement scenarios compared to the reference scenario. The graph clearly shows a significant increase of all 4 enhancement scenarios compared to the reference scenario. Comparing among the 4 alternative enhancement scenarios, as expected, Scenarios 3 and 4 exhibit relatively the highest increases in absolute value and in terms of the rate of increase of international trade flows compared to scenarios 1 and 2. Comparing between Scenarios 1 and 2 we can see that as expected the relative improvement of Scenario 2 over Scenario 1 is minimal.

Figure 3 shows the percent increase of international trade flows for the various enhancement scenarios compared with the reference scenario as of 2012 (for example for Scenario 1,

$\text{the percent increase} = \frac{(162012098 - 37112001)}{37112001} + 1 = 437\%$ as well as its predictions at the target year of 2040,

$\text{the percent increase} = \frac{(162012098 - 110532300)}{110532300} + 1 = 147\%$. Figure 4 shows the absolute values of international trade flows at 2020, 2030 and 2040 for all 4 enhancement scenarios as well as the reference scenario. These figures show that the expected predictions of international trade for Scenario 4 at 2040 would reach around 187 million tons compared with the current volume of around 37 million tons, *i.e.*, Scenario 4 would reach around 504% higher compared to the current flows in 2012. The difference would be around 70% higher for Scenario 4

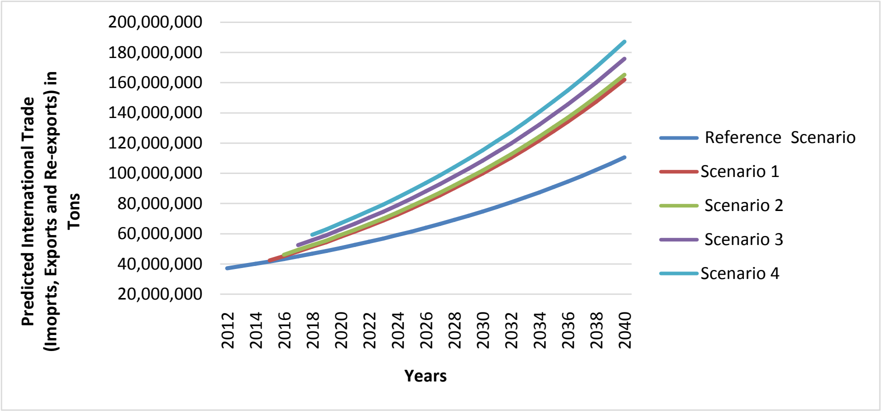

Figure 2. Predicted international trade (imports, exports and re-exports) in tons for reference scenario and 4 enhancement scenarios for 2012-2040.

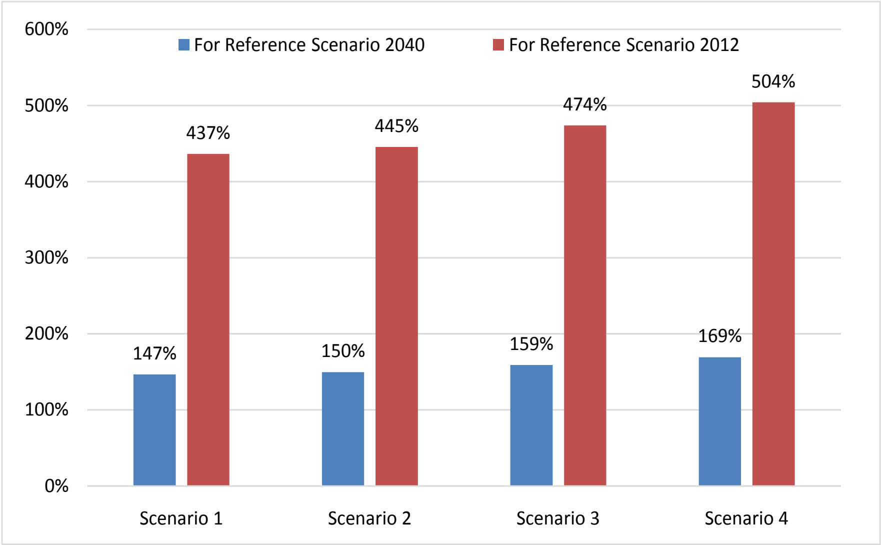

Figure 3. Predicted percent increase of international trade (imports, exports and re-exports) by 2040 for 4 enhancement scenarios compared with the reference scenario for 2012 and 2040.

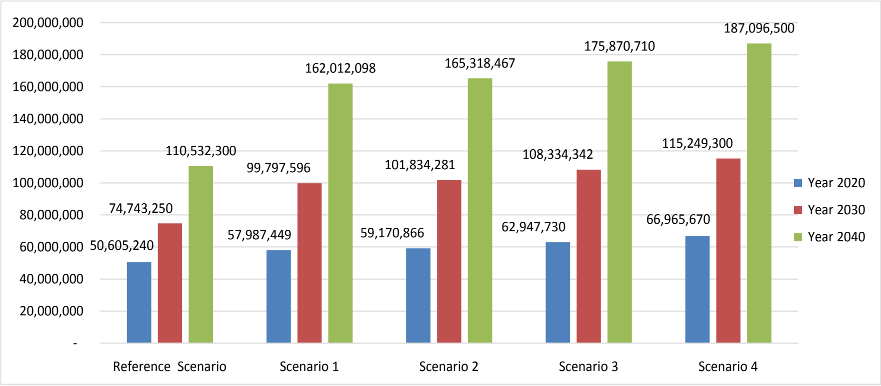

Figure 4. Comparison of predicted international trade (imports, exports and re-exports) in tons between reference scenario and 4 proposed scenarios for years 2020, 2030, and 2040.

compared to the predicted flows by 2040 if we do nothing until that time (*i.e.*, around 110 Million tons).

It is worth noting that Scenario 4 implies that international maritime transport times and costs to Omani ports would be 20% less compared to that for Jebel Ali Port. Hence, for this Scenario 4 to be realized it would need extensive improvements and enhancements of competitiveness and integration of Omani ports relative to UAE ports. Of course, in reality, UAE as well as world ports are constantly improving and enhancing.

4.4. Predicted Total Cost per Ton of International Trade Flows

Table A2-2 in the Appendix 2 and Figure 5 and Figure 6 below show the comparison among the reference scenario and the four proposed enhancement Scenarios 1, 2, 3 and 4 with respect to the total cost per ton in USD. The figures show that the total cost per ton, decreased from an estimated 254 USD per ton for the reference scenario to around a predicted 202 USD per ton for Scenario 4. That is the cost per ton is expected to be decreased by more than 20% for enhancement Scenario 4 compared to the reference scenario (0). This should reflect significant savings to the Omani economy.

4.5. Predicted Average Total Trip Time of International Trade Flows (in Days)

Table A2-3 in the Appendix 2 and Figure 7 and Figure 8 depicted below show the comparison among the reference scenario and the four proposed enhancement scenarios with respect to the average Total Trip Time (in days) over the analysis period 2012-2040. The figures clearly indicate a reduction of this average trip time from 42 days for the reference scenario to 32 days for Scenario 4. That is around 25% decrease of average total trip time. Again this should result in significant savings in trip time for international trade for Oman and hence significant benefits to the Omani economy.

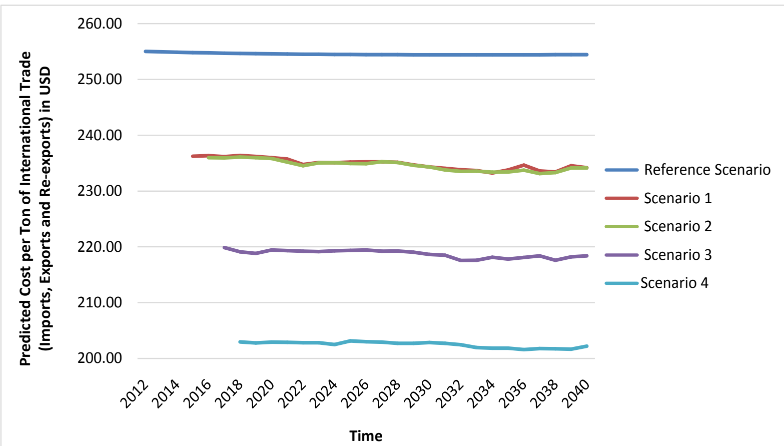

Figure 5. Predicted total cost per ton of international trade (imports, exports and Re-exports) in USD for reference scenario and 4 scenarios for 2012-2040.

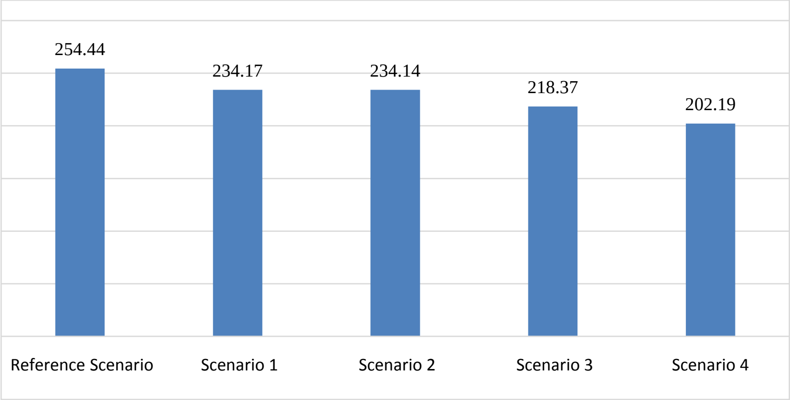

Figure 6. Comparison of predicted total cost per ton in USD for international trade (imports, exports and re-exports) between the reference scenario and the 4 proposed scenarios for year 2040.

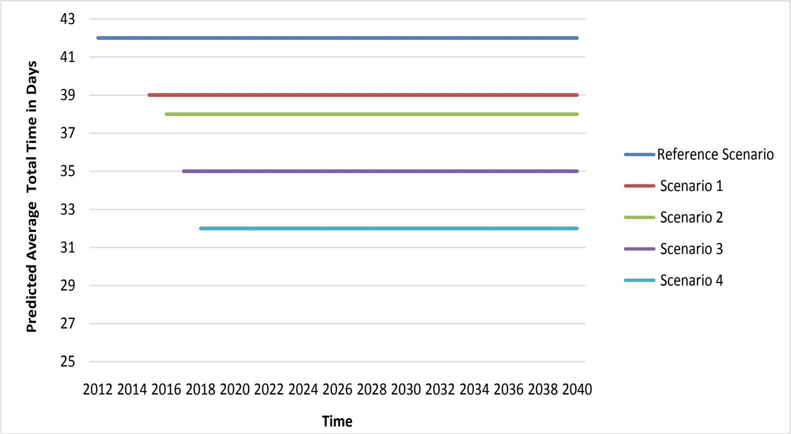

Figure 7. Predicted average total time in days of international trade (imports, exports and re-exports) for reference scenario and 4 enhancement scenarios for 2012-2040.

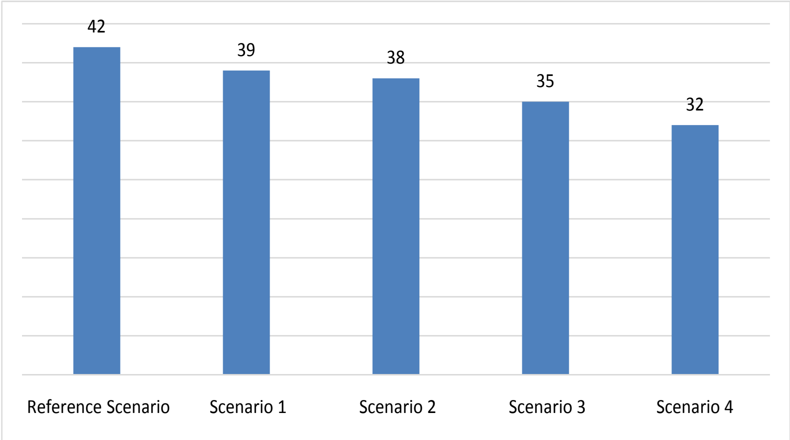

Figure 8. Comparison of average total time in days for international trade (imports, exports and re-exports) between the reference scenario and the 4 proposed enhancement scenarios for year 2040.

5. Conclusions

- The proposed alternative enhancement scenarios were 4 nested scenarios, *i.e.*, each scenario included the previous one plus an additional enhancement. Scenario 1 involved reducing the number of documents from 8 to 4, and Scenario 2 involved Scenario 1 plus reducing the time for port and terminal handling to 1 day (instead of 2 days for imports and 3 days for exports as estimated for 2012 by the World Bank trading across borders report 2013). Scenario 3 involved Scenarios 1 and 2 plus reducing the international maritime transport times and costs by 20% (*i.e.*, to become equal to that of the UAE according to the application assumptions), and Scenario 4 involved Scenarios 1 and 2 plus reducing the international maritime transport times and costs by 40% (*i.e.*, to become 20% less than that of UAE according to the application assumptions). These 4 enhancement scenarios were analyzed against and compared with scenario (0), *i.e.*, the reference "do nothing" scenario.
- The analysis has been achieved in two stages: The first stage involved the prediction of international trade flows (imports, exports and re-exports), times and costs that would result from the application of the 4 alternative enhancement scenarios during the analysis period through the target year of 2040; The second stage involved the assessment of the financial and economic feasibility of the implementation of the 4 alternative enhancement scenarios based on the predictions of stage one and assessment methodology of stage two. The prediction and assessment results were analyzed against the reference scenario.
- The predictions were obtained using an advanced International Freight Simultaneous Transport Equilibrium Model adapted for Oman, *i.e.*, IFSTEM-Oman Model. This IFSTEM-Oman Model belongs to the class of the distinguished simultaneous transport planning equilibrium models. The simultaneous planning models were developed over the past 50 years to overcome a few inherent deficiencies of the well-known traditional sequential transport planning models widely used until today by the majority of consultants and authorities worldwide.
- Several recognized international researchers and practitioners over the previous few decades, including the authors of this paper, have established that the simultaneous equilibrium models consistently produce better predictions (*i.e.*, internally consistent) compared to the sequential transport planning models. This is of course true when both models are compared under similar situations of input data availability and/or limitations.
- The main advantages of the IFSTEM-Oman Model utilized in this paper are that it can predict the expected increase in the total international trade flows within the model in a simultaneous manner replicating the decision making process of the exporter and the importer, unlike the sequential modelling process that does not properly replicate the decision making process of the

importer and the exporter and cannot predict the total international trade flows internally within the modelling process. Hence the IFSTEM-Oman Model predictions of international trade flows, times and costs are relatively more accurate and are internally consistent, unlike the sequential models.

- The prediction results revealed that the estimated international trade flows (imports, exports and re-exports) for Oman for Scenario 4 would increase by more than 504% by 2040 (*i.e.*, around 187 million tons) compared to the present situation of the base year 2012 (*i.e.*, around 37 million tons). This increase would represent around 70% compared to the "do nothing" reference scenario by the year 2040 (*i.e.*, around 110 million tons) assuming that the average increase of international trade flows in the "do nothing" case would be around 4% annually during the analysis period from 2012 to 2040. The predictions of average total trip time and total cost per ton revealed an estimated decrease for Scenario 4 compared to the reference scenario by around 25% and 20% respectively. These results are internally consistent and represented reasonably significant improvements compared to the "do nothing" reference scenario.

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Appendix 1

Input Data for IFSTEM-Oman Model

Table A1-1. Estimates of documents, times and costs of a typical 20-Ft container for exports and imports, from the World Bank (WB) Report 2013 for Oman.

Oman				
Indicator	Export and Re-Export	Import		
Number of documents	8	8		
Time (days)	10	9		
Cost (US$ per container 20-foot)	745	680		
	Export and Re-Export		Import	
Procedures	Time (days)	Cost (US$)	Time (days)	Cost (US$)
Documents preparation	5	285	5	250
Customs clearance and technical control	1	65	1	65
Ports and terminal handling	3	135	2	105
Inland transportation and handling	1	260	1	260
Totals	10	745	9	680
Documents to export	Documents to import			
Bill of lading	Bill of lading			
Certificate of origin	Cargo release order			
Commercial invoice	Certificate of origin			
Customs export declaration	Commercial invoice			
Packing list	Customs import declaration			
Shipping note (pre-advice form)	Packing list			
Technical standard certificate	Technical standard certificate			
Terminal handling receipts	Terminal handling receipts			

Table A1-2. Estimates of documents, times and costs of a Typical 20-Ft container for exports and imports, from the World Bank (WB) Report 2013 for United Arab Emirates.

United Arab Emirates				
Indicator	Export and Re-Export	Import		
Number of documents	4	5		
Time (days)	7	7		
Cost (US$ per container 20-foot)	630	590		
	Export and Re-Export		Import	
Procedures	Time (days)	Cost (US$)	Time (days)	Cost (US$)
Documents preparation	4	215	4	175
Customs clearance and technical control	1	30	1	30
Ports and terminal handling	1	180	1	180
Inland transportation and handling	1	205	1	205
Totals	7	630	7	590
Documents to export	Documents to import			
Bill of lading	Bill of lading			
Certificate of origin	Certificate of origin			
Commercial invoice	Commercial invoice			
Customs export declaration	Customs import declaration			
	Packing list			

Table A1-3. Land transport and handling time (Days) and cost (US$/TEU) from the Muscat to the 5 points of entries/exits.

	Point of Entry	Import		Export		Re-Export	
		Time	Cost	Time	Cost	Time	Cost
Oman	Salalah	2	320	2	320	2	320
	S Qaboos	1	200	1	200	1	200
	Sohar	1	250	1	250	1	250
	Wajajah	1	270	1	270	1	270
	Wadi Jizzi	1	270	1	270	1	270

Table A1-4. Land transport and handling time (Days) and cost (US$/TEU) from Wajajah or Wadi Jizzi to entries/exits land border to given Arab countries.

	Import		Export		Re-Export	
	Time	Cost	Time	Cost	Time	Cost
UAE	2	235	2	235	2	235
SAU	4	835	4	835	4	835
Qatar	4	835	4	835	4	835
Bahrain	4	835	4	835	4	835
Kuwait	4	835	4	835	4	835
Jordan	5	835	5	835	5	835
Syria	7	1335	7	1335	7	1335
Iraq	5	835	5	835	5	835
Yemen	2	320	320	320	2	320

Table A1-5. A sample of 20 out of 140 countries for international maritime transport times (in days) and costs (in USD per 20-ft container) for 2012 for Mina Sultan Qaboos.

No.	Country	Import time	Export time	Import cost	Export cost
1	Afghanistan	12	16	800	1200
2	Albania	32	30	1400	1100
3	Algeria	28	30	1600	1400
4	Angola	30	32	1700	1600
5	Argentina	35	40	2100	1900
6	Australia	40	45	1800	1900
7	Austria	35	40	2000	1800
8	Azerbaijan	28	30	1200	1400
9	Bahamas	24	26	1100	1300
10	Bahrain	14	16	600	800
11	Bangladesh	16	18	800	900
12	Belarus	24	28	900	1100
13	Belgium	26	30	1250	1350
14	Benin	35	40	2000	1800
15	Bosnia Herzegovina	40	45	1800	1900
16	Botswana	30	35	1100	1200
17	Brazil	55	60	2200	2400
18	Bulgaria	50	55	2100	2300
19	Burundi	50	55	2100	2300
20	Cambodia	55	60	2200	2400

Table A1-6. The five highest volume commodities crossing the five entry/exit points.

HS_4DG	HS_4DG Description
207	Meat and edible offal, of the poultry of heading 01.05, fresh, chilled or frozen.
1511	Palm oil and its fractions, whether or not refined, but not chemically modified.
7304	Tubes, pipes and hollow profiles, seamless, of iron (other than cast iron) or steel.
7308	Structures (excluding prefabricated buildings of heading 94.06) and parts of structures (for example, bridges and bridge-sections, lock-gates, towers, lattice masts, roofs, roofing frame-works, doors and windows and their frames and thresholds for doors,
8415	Air conditioning machines, comprising a motor-driven fan and elements for changing the temperature and humidity, including those machines in which the humidity can't be separately regulated.

Appendix 2

Prediction Results for IFSTEM-Oman Model

Table A2-1. Predicted international trade (imports, exports and re-exports) in tons for reference scenario and 4 scenarios for 2012-2040.

Year	The international trade in Tons for reference scenario	The international trade in Tons for Scenario 1	The international trade in Tons for Scenario 2	The international trade in Tons for Scenario 3	The international trade in Tons for Scenario 4
2012	37,112,001				
2013	38,573,610				
2014	40,094,540				
2015	41,677,192	42,306,557			
2016	43,324,030	45,204,958	46,127,508		
2017	45,037,530	48,362,077	49,349,058	52,498,998	
2018	46,820,380	51,407,063	52,456,186	55,804,454	59,366,440
2019	48,675,320	54,432,832	55,543,706	59,089,049	62,860,690
2020	**50,605,240**	**57,987,449**	**59,170,866**	**62,947,730**	**66,965,670**
2021	52,613,080	61,440,042	62,693,921	66,695,660	70,952,830
2022	54,701,890	65,041,367	66,368,742	70,605,045	75,111,750
2023	56,874,960	68,689,661	70,091,490	74,565,415	79,324,910
2024	59,135,620	72,661,872	74,144,767	78,877,412	83,912,140
2025	61,487,290	76,789,335	78,356,464	83,357,940	88,678,660
2026	63,933,620	81,089,265	82,744,148	88,025,689	93,644,350
2027	66,478,420	85,480,412	87,224,910	92,792,457	98,715,380
2028	69,125,580	90,144,317	91,983,997	97,855,316	104,101,400
2029	71,879,110	94,911,251	96,848,215	103,030,016	109,606,400
2030	74,743,250	99,797,596	101,834,281	108,334,342	115,249,300
2031	77,722,500	105,069,972	107,214,257	114,057,720	121,338,000
2032	80,821,330	110,254,975	112,505,077	119,686,252	127,325,800
2033	84,044,570	115,941,351	118,307,501	125,859,044	133,892,600
2034	87,397,110	121,806,282	124,292,124	132,225,664	140,665,600
2035	90,884,150	127,908,563	130,518,942	138,849,938	147,712,700
2036	94,511,100	134,114,496	136,851,526	145,586,730	154,879,500
2037	98,283,430	140,691,046	143,562,291	152,725,842	162,474,300
2038	102,207,100	147,425,281	150,433,960	160,036,128	170,251,200
2039	106,287,900	154,697,604	157,854,698	167,930,530	178,649,500
2040	110,532,300	162,012,098	165,318,467	175,870,710	187,096,500

Table A2-2. Predicted cost per ton of international trade (imports, exports and re-exports) in USD for reference scenario and 4 scenarios for 2012-2040.

Year	Total cost per Ton (USD) for reference scenario	Total cost per Ton (USD) for Scenario 1	Total cost per Ton (USD) for Scenario 2	Total cost per Ton (USD) for Scenario 3	Total cost per Ton (USD) for Scenario 4
2012	255.02				
2013	254.95				
2014	254.88				
2015	254.82	236.23			
2016	254.76	236.36	235.987		
2017	254.71	236.17	235.9573	219.859	
2018	254.66	236.39	236.096	219.0882	202.9488
2019	254.62	236.18	235.9646	218.8203	202.7789
2020	254.59	235.98	235.8499	219.4151	202.9237
2021	254.56	235.74	235.1868	219.3325	202.8828
2022	254.53	234.75	234.5462	219.2228	202.8038
2023	254.50	235.10	235.0502	219.1215	202.8226
2024	254.48	235.08	235.0682	219.2917	202.4824
2025	254.47	235.17	234.9347	219.3556	203.1174
2026	254.45	235.23	234.9049	219.4358	202.9796
2027	254.44	235.23	235.2696	219.2267	202.9078
2028	254.43	235.16	235.0936	219.2464	202.6981
2029	254.42	234.68	234.6168	219.034	202.6909
2030	254.42	234.33	234.3177	218.6331	202.8236
2031	254.41	234.08	233.7588	218.4723	202.6829
2032	254.41	233.82	233.5228	217.5586	202.4453
2033	254.41	233.65	233.5644	217.5911	201.9525
2034	254.41	233.22	233.3596	218.1222	201.8384
2035	254.41	233.77	233.4182	217.8148	201.8288
2036	254.42	234.63	233.728	218.0744	201.5846
2037	254.42	233.58	233.114	218.3752	201.7465
2038	254.43	233.42	233.2973	217.5719	201.7378
2039	254.43	234.53	234.1501	218.197	201.6447
2040	254.44	234.17	234.1394	218.3735	202.1851

Table A2-3. Predicted average total time in days of international trade (imports, exports and re-exports) for reference scenario and 4 scenarios for 2012-2040.

Year	Average times in days for reference scenario	Average times in days for Scenario 1	Average times in days for Scenario 2	Average times in days for Scenario 3	Average times in days for Scenario 4
2012	42				
2013	42				
2014	42				
2015	42	39			
2016	42	39	38		
2017	42	39	38	35	
2018	42	39	38	35	32
2019	42	39	38	35	32
2020	42	39	38	35	32
2021	42	39	38	35	32
2022	42	39	38	35	32
2023	42	39	38	35	32
2024	42	39	38	35	32
2025	42	39	38	35	32
2026	42	39	38	35	32
2027	42	39	38	35	32
2028	42	39	38	35	32
2029	42	39	38	35	32
2030	42	39	38	35	32
2031	42	39	38	35	32
2032	42	39	38	35	32
2033	42	39	38	35	32
2034	42	39	38	35	32
2035	42	39	38	35	32
2036	42	39	38	35	32
2037	42	39	38	35	32
2038	42	39	38	35	32
2039	42	39	38	35	32
2040	42	39	38	35	32