European Journal of Academic Essays 1(2): 48-55, 2014
ISSN: 2183-1904
www.euroessays.org

A New Model for Freight Rail Access Charge in Iran Railway

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Abstract: Costs of railway network are significant factors in setting access charge. The access charge should firstly, cover the costs, secondly, provide the source of rail development and finally, make the effective competition possible. The aim of this paper is to develop a new access charge model compatible with Iran's Railway situation, based on the experiences of advanced countries. Total cost of railway, tariff zoning and gross ton-kilometer are the considered factors in the suggested model. Comparing the structure and results of the proposed model with the current model used in Iran's Railway, it is proved our model is not only valid but also reaches more reasonable results for the corresponding railway.

Keywords: Iran Railway, Freight Rail, Access Charge, FC- principle, Regional Factor.

1. Introduction

Nowadays, policy making and economic growth have tight relation with transportation network and facilities in every country. The demand for rail transportation is quickly increasing as well as the freight transportation. Considering the natural and unique characteristics, although railway is known to be a high fixed-cost transportation, but it is more efficient against other transportation modes. On the other hand, the cost per unit (ton-kilometer) in this mode has competitive advantages against the other modes.

Due to the strategic geographical situation of Iranian railway freight structure and legislation of the government, it is inevitable to purposively plan for developing the freight transportation and consequently to increase the demand for it. In this way and to move along with top policies of the country, Iranian railway has begun the railway transportation privatization since 2005.

Along with privatization, the Infrastructure and Railway Operation are separated in two individual sections, in which the infrastructure section and the operation section are assigned to the government and the private corporations, respectively. Therefore, the operator has to pay access charge to Infrastructure owner because of the access to network and operation. So, how the private sector should participate in rail transportation has been analyzed and wide efforts have been accomplished to define suitable access charge model to the network. Each model has to cover the costs and expected margins for the investors. Due to high level of investment costs and risk in rail transportation, the pricing has to be in such a way that covers costs as much as possible and develops railway market.

The demand share of railway transportation may increase by defining an appropriate model for access charge to rail network from one side, and improving reliability of network from the other side. The costs of network such as maintenance/repair, wear and tear and fuel have high importance in defining access charge. They must be taken into account and computed exactly because of high cost of network and covering that costs.

Due to this, concentration on access charge models of railways and their pricing principles can prepare a useful and applicable basis to continue. In this way, one of the best resources of access charge studies is the result of European Conference of Minister of Transport [1]. It has been prepared a report for pluralizing the results of that about pricing policies, interaction between state and railways, problems, approaches in rail section, evaluations, pricing method and tariff levels in EC using information on behalf of EC railways. Chris Nash [2] has reviewed results of a survey of rail infrastructure charges in Europe, presenting evidence on the structure and level of charges across 23 countries. The differences between models and reasons of that also have been examined. Through a study by EIM and CER [3] it has been examined generally the rail structure, accounting system and access charge model of six European railways. Prodan [4] also for obtaining Msc degree had a study on Infrastructure pricing models and through that he examined the access charge of 6 Railway in HSR section. He also had a glance on pricing principles. Calvo and De Ona [5] also studied a series of national charging systems to compare track usage costs and the charges that seek to recover those costs. They also examined the pricing levels applied to railway services to study the coherence between national charging systems and the charging principle on which they are based. Peter Benedikt [6] after review on cost function and various types of cost in railway had a study on pricing principles and types of tariffs. He classified the access

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charge models in EU based on pricing principles. Besides these studies about access charges in EU railways, Nikolova [7] proposed a new model in Bulgaria and discussed the problems of existing charging system and recommended solutions for that. He also proposed a model for rail infrastructure costs estimation. All these studies prepare a useful source for studying the access charge system of advanced countries. Access models based on pricing principles, important factors and their applying, cost recovery of models and etc. are useful tools to define and to propose appropriate model for Iran railway.

In total and as a result of studies, three pricing approaches can be identified (such as ECMT):

- Social marginal cost pricing with State compensation for the difference between marginal costs and financial cost. It is the additional cost that each user imposes on the infrastructure provider as a result of operating the infrastructure (**SMC**);
- Marginal Cost pricing with Mark-Ups that has the same base as MC approach, but aimed at reducing (or eliminating) State compensation and the gap between marginal cost and financial cost (**MC+**);
- Next approach will be the difference between two variables full financial costs and the government support (**FC-**).

To compare these approaches, there are two important flaws with **SMC** approach: the most pressure on State budgets and a need to an accurate calculation of the marginal costs. But, it yields the most efficient use of the infrastructure.

The best balance between efficiency and budget can be reached by **MC+** approach and may be completely consistent with achieving the goals of the FC– approach.

And finally, the **FC–** approach may produce inefficiencies in use of the network, unlike two aforementioned approaches. However, it protects infrastructure manager financially.

But, two philosophies (MC and FC) can be compatible. Marginal cost can determine the company's pricing floor and charging above marginal cost, on average, will be necessary for an unsubsidized body. Therefore, it cannot be said that pure marginal cost pricing is desirable every time.

But, the access charge regimes have generally been established either by using simple tariffs or by two part tariff. Two part tariffs in which one part is variable with use and one part is fixed in advance in relation to expected capacity requirements (usually scheduled train-paths or train path-km). And simple tariffs vary directly with use of the network (gross ton-km and train-km.

Due to all points, it has been used simple tariff that varies with gross ton-km measure, in proposed model. The implementation of this system is easy and less costly. Also, duo to concentration on domestic freight market, simple tariff can increase competition between operators (unlike two part tariff). Unused capacity of existent network and limited number of active operators are another reason for using simple tariff based on gross ton-km measure. In other word, due to low speed of investment and adding capacity to network, because of financial constraint, improving the utilization of existent network is superior. So, to give better signal to full using the existence capacity, it has to be considered encouraging approaches.

However, two part tariff is useful for network where more than MC pricing is needed (like Iran that state funds is limited), but fixed variable is defined in networks that path reservation and scheduling concepts are exist and network is complex, moreover, the philosophy of fixed part is about recovering initial investment cost. Because of not complexity of Iran's network, lack of freight scheduling and not applying mark-ups for initial investment cost, applying costs more than MC in the structure of simple tariff can be reasonable. To apply charge above MC we considered FC-concept except initial investment cost (that makes more and more two approaches the same). Using a gross ton-km measure, we can be confident about considering maintenance and renewal cost that is important for IM, because the annual wear and tear costs on tracks are more heavily influenced by gross ton-km (MC pricing). Due to unused capacity of network and similarity of freight trains (the majority of freights are mineral) in Iran, this measure can be compatible. Besides, to overcome the problem with measuring MC of trains and to apply at least MC charge, FC- (except initial investment) in the shape of simple tariff ensures somehow applying more than MC charge. In other hand, it removes more and more of the IM problems of recovery deficits (because of top-down view to costs, all of them include total maintenance/ renewal is distributed among transportation units).

In next section we examine computing models of freight access charge in Iran. In section 3 the necessity of modifying current model of access charge in Iran is investigated. Our new model is proposed in section 4 and in the final section the efficiency of model is examined by implementing on a case study.

2. Models of computing access charge in Iran railway in the past three decade

Until 2005, a context called "transport fare" (fare for freight) was being used. The computing basis of this context was categories of freight which were nominated based on load types and assigning a rate to each of them. Computing the fare was done by multiplying weight, distance and base-tariff. The weight factor was considered to be weight of wagon regardless to the weight of freight in each wagon. In this model, the absence of tariff based on categories of freight in road transportation, was another railway's infirmity in attracting of demand.

After failure in first effort of privatization (before 2005) and by implementing new privatization process (2005), approaches such as rate liberalization and changing in railway tariff unit from ton-kilometer to axle- kilometer were considered. In this method, the following parameters were noted: number of wagon axles, distance and base-tariff rate – which is based on wagon's type, being full or empty and axle-load of path. These modifications led to no direct effect of wagon's weight in computations, considering axle-load in defining base-tariff rate, difference in rate of empty and full wagon, encourage to "two-side transportation" (Movement of train in departure and return with load in a defined route) and container transportation.

3. Necessity of modifying the current model

Regarding the aforementioned explanations, it is necessary to modify the access charge model. The most important reasons for that are: problems in current model, rate liberalization and privatization. About problems of current model, there are some flaws that lead to lose the rail attraction: ignoring cost of railway and increasing the rate by 10-12 % annually (no pricing principle); ignoring the effects of geographical and infrastructure characteristic (no attention to cost structures); computation based on maximum capacity of wagon and ignoring freight weight (no customer support).

4. Proposed model for computing access charge to rail

As parts of the development process of the new Access charge model, first, the list of concepts will be presented and discussed. Then, the tariff structure and relative computation of components are introduced.

4.1. Concepts in new model

This section will consider possible variables for the proposed tariff model.

4.1.1. Technical characteristics of Infrastructure and technical structures for each area

Significant part of railway cost relates to maintenance of infrastructure, lines and structures costs. So, defining the length of lines in each path, constructions of stations, other structures such as bridges and tunnels and also average cost of their maintenance in each path, must be counted in computing access charge. Labor cost and current cost must be considered.

4.1.2. Considering geographical condition of each area: Path-based charge

Geographical condition is an effective factor for discrimination in different areas. In the other side, because of organizational persistence against fundamental changes, it seems this work has to be done gradually and it has to be the same with the current paths firstly. But, doing this work is inevitable by locomotive privatization and importance of finding and homogenization similar paths. In order to divide railway lines into different paths and compute the corresponding access charge, the geographical characteristics of each path and parameters such as slope, distance between stations, axle-load, maximum speed, and maximum length of train in that path must be gathered and applied in the access charge.

4.1.3. Considering input and output tonnage of each area

Undoubtedly, the demand is one of the most important parameters in access charge computing. This factor is computed based on the volume of freight transferring in each path. For this purpose, it is defined the input and output freight volume of station placed in each path, demand volume and number of train that is needed in each path monthly and yearly (maybe daily for high traffic path), and maximum length of train by considering locomotive specification, stations, infrastructure.

4.1.4. Costs of locomotive

The proposed system is based on train-kilometer and locomotive as one of the components of that. It should be noted in spite of the privatization, locomotives are owned by the government yet. So, all of its significant costs such as fuel and maintenance must be applied in access charge.

4.1.5. State funds

Although in most railways, government assigns monetary help for covering the gap between total costs and the revenue from access charge annually, but ideally this fund should be used in research activities and development of infrastructure which is considered in our model. Therefore, it seems that the access charge system should be calculated by the formula which lets the fund to be consumed as privatization subsidy and covers the aforementioned gap in first years. Then, this fund should be consumed for Infrastructure development and also the revenue from charge covers annual costs.

4.1.6. Annual transit revenue

Since a part of railway revenue relates to transit, removing it from the annual costs has an indirect effect on reducing charge rate and has to be considered in defining access charge.

4.1.7. Base-rate per gross ton-kilometer

In the proposed model, the computation is based on gross ton-kilometer. The reason is to evaluate the current operation and then each areas and paths. This factor shows traffic level of trains and volume of transferred freight. Also by using this factor, higher accuracy in estimation of revenue for covering costs and preventing customers from paying for all capacity of wagon, are occurred.

4.2. New model

Considering the deficiencies of current model and the necessity of its development, this model is proposed after investigations of access charge in some countries and also noting the circumstances of Iran. The model is proposed as

$$T_{EM} = C_1 . C_2 . L . F . Q_T \tag{1}$$

Where:

C1 and C2 denote the load type and the regional factors, respectively. L is the length of travel, F shoes the base-rate, and also Q_T is the gross ton-kilometer.

Especially about load type factors, values can be assumed as follows (Table 1). These values are hypothetical to show importance degree between types.

Table1: Load type coefficients

Load type	Coef.
Conventional	1
Dangerous	1.5
Out of gauge	Depend on experts
Out of timetable	1.2

It is suggested that price of freight with internal destination (i.e. the origin and destination are in the same path) to be separated from freight with external one by a factor considers the demand in each path.

4.3. Calculation method

The first purpose of this model is covering the annual costs of railway and then profitability in future years and consequently assigning fund to research and infrastructure development. So, the basis of base-rate and regional factor is annual costs of railway and transit revenue.

4.3.1. Annual costs in railway

Since the new model calculation is done based on the annual cost and regionally, it is essential to have the annual costs classified by area and type. In the current system the costs are classified into six sections:

- Operating costs: Cost of goods or services production
- Administrative costs: Cost of services and supports
- Commercial costs: the cost of distribution and sales of goods or services

- Debt: repayment of previous years debts in current year
- Depreciation costs: costs for depreciation of facilities, equipment, etc.
- Financial costs: all the costs imposed to company by bond interest and contributions as well as loans lot.

In table 2, the costs of railway in 2009 are shown.

Table2: Costs of Iran Railway (Million Rials)
Source: Archive of Iran Railway Research Center, 2009

Description	Amount
Operational	3462553
Administrative	683715
Commercial	69752
Debts	47548
Depreciation	1806043
Financial	7789
Sum	**6077400**

4.3.2. Transit revenue

The transferred freights include domestic and transit freights. The bills of loading the domestic and international freights are issued separately and consequently their computation methods and payments are different. Because of our concentration on domestic charges, it is necessary to consider just statics of that. So, the statics about transit freight has to be removed from the computation, as it is a part of railway revenue and covers the incurred costs of transit transportation. Table 3 shows the transit revenue for 2009 divided areas.

Table3: Transit Revenue by areas (Million Rials)
Source: Archive of Iran Railway Research Center, 2009

Areas	Amount
South	0
Arak	0
East	12674
South east	11
North	0
Khorasan	566675
Azarbayjan	10807
Hormozgan	65909
Total	**656076**

4.3.3. Annual net cost

The costs of railway include fixed and variable costs. The former are those constant with the variation of traffic volume and are affected by time and money value, inflation and their estimation are on responsibility of top managers. But the latter are in relation with variation of traffic volume. Subject to the variable costs (such as fuel, maintenance and etc.), unit cost has to be estimated based on a criterion (suggested gross ton-kilometer) in first and then the sum of these costs has to be estimated in relation to the estimated demand for next year. After estimation of costs and revenue for next year and removing transit revenue from sum of annual cost of areas, offices and railway factories, we reach to a net cost. If this cost be covered by revenue from domestic transportation, not only the railway does not lose but reaching to profit will be possible by increasing demand and revenue. This cost that is called from now “annual railway net cost” and will be the basis of our computations.

$$Annual\ net\ \cos t = annual\ total\ \cos t - annual\ transit\ revenue \qquad (2)$$

4.3.4. Defining the base- rate

By comparing the operation and total costs of network, the base-rate can be computed for all of paths equally for covering estimated costs of next year and earning expected revenue. Multiplying regional factor in base-rate defines the rate of each area.

So, it is used from the annual gross ton-kilometer of freight trains for defining the railway operation and demand forecasting. After that, we reach base-rate by dividing the annual net cost by annual gross ton-kilometer of network and its unit is Rial in ton-kilometer.

To prevention of sudden jump in rates, a fourth-year funding plan is suggested. But, it should be noted the need to state fund will be less than estimated amount in each year. So, using from state fund is suggested as follow in table 4:

Table4: Proposed assignment of state funds (Million Rials)

Year	State fund
First	1336433 (Current condition for 2009)
Second	800000
Third	400000
Forth	0

So, base-rate is computed from this:

$$Base - Rate = \frac{Net\ Cost\ (including\ State\ Fund)}{Gross\ Ton - Kilometer\ for\ Freight\ Trains} \qquad (3)$$

4.3.5. Defining regional factor

There are some elements affect regional factor such as slope, demand and cost of path including stations, technical structures, infrastructure, current, general administration, commercial and etc. This factor is computed after comparing operations and costs of each area with base-rate.

First, the operation of areas has to be evaluated in relation to the total operation of railway. The basis of this work is the ratio of gross ton-kilometer of each area to the total gross ton-kilometer of network. Next step is defining costs of each area that are divided into two parts. The first is the special costs of each area and the other is prorated costs to area including total offices of railway, factories and researches. Special costs of each area involves operation, commercial, administrative, debt and depreciation. Prorated costs must be divided proportional to operation of areas (e.g. Table 5). The logic of this work is assigning more costs to revenue making areas and fewer costs to high rate areas naturally. By justly distribution of costs, we will be able to prevent high rates. Assigning transit revenue is assigned to all areas based on their operation. This revenue is subject to the whole railway not a special area. In terms of macro-management, the reason is integrating of railway and In terms of micro-management, it can be said moving trains from paths and areas and using infrastructure facilities imposes costs to areas so the areas must have a share in transit revenue. This object can be reached by assigning transit revenue in relation to operation of areas.

After defining the way of computing costs and revenue of areas, rate of areas has to be computed. It is because defining regional factors is done by considering the rate of areas and base-rate. The objective of new model is differentiation based on geographical and geometric characteristics of each path and area. Due to the different cost of areas originated from these factors, this approach can be a good way to define regional factors.

Table5: Costs and Revenue of Hormozgan (Million Rials)

Components	Amount
Special cost	258522
Prorated cost	727365.3
Share of transit revenue	152340.7
Share of state fund	310319.7
Annual net cost	523226.9

$$Rate\ of\ \ Hormozgan\ for\ \ 2009 = \frac{523226.9 \times 1000000}{8691608081} = 60.20\ \frac{Rial}{Tone\text{ - }Kilomete} \qquad (4)$$

Considering the concentration of domestic freights on a special district of railway network and high volume of freight transportation in road in this district, a mechanism is needed for keeping this volume in rail and attracting the freight from road to rail. So, for integrating rates in this areas and adjustment of high rates in some other areas, an equal rate is considered for these areas. This rate is computed by weighted average of rates in the areas and the share of them from rail market. It has to be noticed that the similarity of geographical and geometric characteristics and continuity of paths are of the other reasons for rate integration (Table 6 and 7).

4.3.6. Path grouping

As it is been mentioned, to prevent high level changes in regional railway departments, path grouping is based on the current paths. It does not mean this grouping is the best, but it’s appropriate for developing objectives. These paths are:

- Tehran – Sarakhs
- Bafq-Sarakhs
- Bandar Abas-Bafq
- Bafq- Mohammadieh
- Mohammadieh-Tehran
- Bandar Imam Khomeini- Mohamadieh
- Garmsar-Gorgan
- Tehran-Jolfa
- Bafq- Mirjaveh

Also, in this grouping, some factors have been considered such as similarity of geometric characteristics, operation relation to total and potential demand.

Table6: Base-Rate and Rate of areas (Rial/Ton-KM)

<table>
<tr><th>Areas</th><th>Share of annual total gross ton-kilometer (%)</th><th>Maximum Gradient (‰)</th><th>Rate of area (Rial/Ton-KM)</th><th>Share of annual total gross ton-kilometer</th><th>Base rate</th></tr>
<tr><td>Hormozgan</td><td>23.22</td><td>12</td><td>60.20</td><td rowspan="10">96.04</td><td rowspan="14">109.13</td></tr>
<tr><td>Yazd</td><td>16.49</td><td>15</td><td>64.56</td></tr>
<tr><td>Esfahan</td><td>17.25</td><td>15</td><td>69.12</td></tr>
<tr><td>East</td><td>7.25</td><td>15</td><td>72.50</td></tr>
<tr><td>Tehran</td><td>10.47</td><td>14</td><td>106.22</td></tr>
<tr><td>Arak</td><td>5.74</td><td>16</td><td>139.91</td></tr>
<tr><td>North-east</td><td>3.55</td><td>15</td><td>156.26</td></tr>
<tr><td>South</td><td>3.96</td><td>3</td><td>162.91</td></tr>
<tr><td>Lorestan</td><td>3.57</td><td>16</td><td>206.53</td></tr>
<tr><td>Khorasan</td><td>4.55</td><td>15</td><td>224.22</td></tr>
<tr><td>Kerman</td><td>0.49</td><td>10</td><td>324.06</td><td>0.49</td></tr>
<tr><td>North-west</td><td>1.66</td><td>14</td><td>324.79</td><td rowspan="2">2.41</td></tr>
<tr><td>Azarbayjan</td><td>0.76</td><td>28</td><td>857.58</td></tr>
<tr><td>North</td><td>1.06</td><td>28</td><td>525.94</td><td>1.06</td></tr>
</table>

Table7: Moderated Rate of areas and Regional Factors

<table>
<tr><th>Areas</th><th>Khorasan</th><th>Hormozgan</th><th>Yazd</th><th>Esfahan</th><th>East</th><th>North-east</th><th>Arak</th><th>Lorestan</th><th>South</th><th>Kerman</th><th>North-west</th><th>Azarbayjan</th><th>North</th></tr>
<tr><td>Regional rate</td><td colspan="9">94.24</td><td>323.55</td><td colspan="2">492.08</td><td>523.73</td></tr>
<tr><td>Regional factor</td><td colspan="9">0.864</td><td>2.96</td><td colspan="2">4.51</td><td>4.80</td></tr>
</table>

5. Implementation

In order to implement the model, the “Bafq-Bandar Abas” path is chosen and two scenarios are employed.

5.1. First scenario

The scenario is proposed when the goal is changing in the access charge, but not scheduling the freight railway. So, the model proposed in 4.2 is used. But, some assumption has been considered:

- The base-rate and regional factor for Hormozgan obtained 109.13 $\frac{Rial}{Tone - Kilometer}$ and 0.864.
- Load type: conventional, length of path: 653 kilometer and axle load: 22.5 tones.
- The wagon status: full in departure (maximum capacity), and empty in return
- Technical specification for wagons is shown in table 8 (the specifications are mostly frequent in the network of 4-axle system):

Table8: Wagons Technical Specification
Source: Archive of Iran Railway Research Center, 2009

Wagon type	Loading tonnage (tone)	Wagon weight(tone)
High-Sided	67	23
Tank wagon	65.5	24.5
Low-Sided	64	26
Flat Wagon	66	24

- Current access charge rate of the wagons is shown here for the year 2009:

Table9: Current base tariff rate (Rial)
Source: Archive of Iran Railway Research Center, 2009

	High-sided	Tank Wagon	Low-Sided and Flat Wagon
Axle Load (ton)	22.5	22.5	22.5
Loaded (Rial)	2545	2741	2122
Empty (Rial)	849	2122	707

Now, the comparison between new and current access charge models for wagons can be computed (Table 10). As it is seen, amount of access charge in new model has been decreased significantly. Applying new model in aforementioned paths, we can reach significant comparative advantage against road transportation and the share of railway transportation can be increased. Besides, Using the new model in return movement (empty status), access charge has been decreased and due to “one-side” freight transportation in Iran (Movement of train in departure with load and empty in return in a defined route), supporting the rights of customer will be possible.

In new model, the amount of access charge for high sided car and tank wagon grow more than flat wagon and low sided car. For high sided cars, as the share of freight transported by these type of wagons is high, it seems increasing the amount of access charge can be more profitable (i.e. sensitivity of this type of wagons to price is low). Also for tank wagons, the potential demand for transferring oil shipment is because of the property of country. So, decreasing the access charge can increase the demand for this load.

Therefore, using new model, effects of wagon type and being full/empty in the access charge are observed. It is also worth to say in the new model, each customer pays for amount of load not for maximum capacity of wagon unlike the current system.

5.2. Second scenario

In this scenario, beside the changing access charge model, railway will be scheduled due to the fixed movement of defined number of trains for transferring specific amount of freights. So, if the trains move with the freight lower than estimated loads, the railway will be affected. The assumptions of this scenario are:

- Assumptions of scenario1.
- b) The line capacity of this path is 32 freight trains in a day [8].
- c) Used locomotive in computations is GT26, due to the high share of this type in the country.

Amount of access charge in this scenario is based on the train-kilometer. Computation of customer payment is based on the share of customer from the formed train. The computation model is the same first scenario.

As mentioned, daily capacity of this path is 32 freight trains and in a year would be 11680(365*32). On the other side, total gross tonnage of this path in 2009 has been 10003857. Dividing this tonnage to the maximum number of trains, the minimum capacity of trains required to form is 856.5 tons. So, if trains to be formed with the freight lower than this amount, railway will not be able to transfer all of the demand and to reach estimated revenue. Therefore, all the trains formed with the freight lower than this amount, must pay for 856.5 tons. On the other side, since the based locomotive is considered GT26 and its traction effort (for current condition of country) is 1650 tons, formed trains with the freight higher than this amount (with more powerful tractions) must pay a few more charges for 1650 tons. By improving the traction effort in the railway network, some modifications will be required.

Table 10: Comparison of current and new access charge

Path	Wagon Type	Current Access charge (Rial)			New Access charge (Rial)		
		Departure	Return	Sum	Departure	Return	Sum
Bandar Abbaas-Bafq	High- sided	6647540	2217588	8865128	5540836	1415991	6956827
	Tank Wagon	7159492	2387368	9546860	5540836	1508338	7049174
	Low- Sided	5542664	1846684	7389348	5540836	1600685	7141521
	Flat Wagon	5542664	1846684	7389348	5540836	1477556	7018392

This scenario provides an appropriate field for scheduling the freight trains and therefore increasing the reliability of rail transportation and consequently it can increase the demand for the railway. Also applying this scenario creates an incentive to enhance the fleets. Meanwhile, increasing the load factor of wagons associated with the management of train movement in the network is one of the advantages of this scenario. Moreover, decreasing the movements' time and stops can also decreases the "Redouance" (the charge is paid by Iran to CIS countries for movement of CIS's wagon in Iran) costs for Iran railway.

6. Popularizing the model for future

Proposed model of the article deals with the access charge for current condition of Iranian railway. However, in case of scheduling the freight railway and assigning the locomotive to private section, it is needed to accomplish some modifications in the model as:

- Adding gross tonnage coefficient to model (in case of scheduling)

If the trains must move with the freight lower than forecasted amount, it is needed to a mechanism to prevent loss and also to attract the customers to transfer their freight with the more tonnage trains. Hence, the number of low tonnage trains will be decreased and also forecasted revenue will be reached.

In continue the minimum and maximum numbers of available trains to be moved in each path must be defined. Minimum number is defined as described in section 5.2 and the corresponding movable tonnage is the loading capacity of defined trains, shown by A. For computing the maximum number of trains, it is needed to have a line capacity study. Then, dividing estimated freight tonnage of the studied year by maximum number of trains, will determine the minimum movable tonnage for each train, shown by B. Thus, it is needed to prepare a table such Table 11.

- Removing locomotive cost after its privatization

The privatization of locomotive is being performed and one of the most important problems for this task is computation of locomotive costs and charges. Implementing the new model, it is enough to compute the locomotive costs based on gross ton-kilometer in each path. Then, by subtracting the total cost of locomotives movements from the annual net cost in a defined path, we reach to a new charge rate. The difference between past and this rate will be base – rate for locomotives. Although, in case of scheduling the freight railway, the computations will be more accurate since the movements of locomotives are specified. Also, our computation was based on one the locomotive type. So defining a locomotive type factor in the model, can lead the private section to enhance the locomotive with higher traction effort and lower costs. Consequently, increasing the transferred tonnage with new locomotives provides more revenue for the corporations.

Table11: Proposed Gross Tonnage Coefficients

Gross	Gross tonnage Coefficient
A≥	1
…..	…..
Tonnage ≤B	Coefficient >1 (depend on the charge rate in area)

- Capability of assigning the line capacity for specific time to private section

After assigning the locomotives to private section, the average cost share of each train in the network will be computed. Considering the capacity and forecasted load for each path, private corporations own the locomotives can gain the privilege of exclusive use for a specific slot against payment defined by railway.

- Grouping locomotive and assigning each group to special path

It is possible to classify the locomotives based on the traction effort and to assign each group to a special path. This work is done by considering the available and estimated tonnage in each path, geometric characteristics of the path, and the number and technical characteristics of available locomotives. Therefore, optimized usage of traction effort will be reachable. Also, it is possible to define the number of locomotives and traction effort needed for better operations. This information can be sent to the private section for planning.

- Defining number of virtual trains in scheduling the freight train

To overcome on load fluctuation, demand increment and capability to transfer out of timetabled freight trains, adding demand factor can be suitable. In this way, it is needed to do demand study in each path and then apply it in the form of a coefficient. Increased trains associated by this coefficient will be virtual trains in each path.

7. Conclusion

In this paper a new model for access charge has been provided for the Iran freight Railway based on the regional factors and privatization to remove the deficiencies of the current system. Applying the model we concluded new waves of rail privatization are coming by fleet privatization. In the privatization, we need to prepare a proper scheme and to define a reliable assigning framework. One of the most important actions before starting the aforementioned tasks is to change the open access law and access charge compatible with the conditions after fleet privatization. In this way, proposed model not only has these characteristics but it is better than the current model in terms of charge level and it also considers geographical situations of Iranian railway. Moving toward increasing revenue in a five years plan can be the best incentive for entrance of private section to railway. For this aim, two scenarios were proposed which the first one can be operational in a four years plan and from the beginning of the fifth year, scheduling freight railway and train- kilometer access charge be applied based on the second scenario. Moreover, the model was examined in a practical path and compared with the current system and reached to lower tariff levels and finally a number of complementary points for the future model were proposed.

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Author Profile

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