Journal of the Persian Gulf
(Marine Science)/Vol. 7/No. 25/ September 2016/12/37-48

Identifying and Prioritizing Effective Factors in Constructing Dry Ports in Iran

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Received: June 2016 *Accepted: September 2016*

Abstract

This research aims at identifying and ranking the effective factors in constructing dry ports in Iran. Initially, by reviewing the literature and inputs from professionals, 20 important criteria impacting constructing dry ports were identified,categorized under three groups of infrastructure, hardware and software and data were collected through questionnaire. Questionnaire's validity was determined by university professors and professionals and reliability of the questionnaire was evaluated by Cronbach's Alpha, which showed an acceptable level of 0.789. Collected data were analyzed by appropriate tatistical tests. The results showed that the main dimensions of software, hardware and infrastructure were the most effective factors in constructing dry ports in Iran respectively. Moreover, of the 20 identified criteria, "the availability of the equipment and facilities for loading and unloading", "providing the customs and clearance services", "access to the national and international main routes (hinterland)" were the most important criteria and have had the most effects on constructing dry ports. Criteria such as "access to the empty container for commercial transactions", "proximity to the production markets and "access to the borders" showed the least effect on constructing dry ports in Iran.

Keywords: *Seaports, Intermodal Transportation, Port Operation, Dry Ports.*

1. Introduction

Commencement of containerization dates back to mid-1950s, and because of its unique features, has played a vital role in regional and international economy and commerce. In the last 20 years or so, the growth of containerization has intensified, and its traffic volume has multiplied accordingly. This is an ongoing trend in container trade and its impacts are two-fold. First, it triggers the construction of larger container ships with higher carrying capacity to respond to the worldwide growth of container transportation demand; and second, it calls for appropriate arrangements in ports to deal with increased activities because of increased container traffic. An arrangement, which proved to be very useful in easing the pressures of high congestion of container terminal, is the concept of 'dry ports' (Arabshahi et. al, 2010). The development of inland

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terminals or dry ports is one of the approaches that attracted more attention in the past years to reduce seaport congestion, greenhouse gas (GHG) emissions, and the environmental impact on the seaport surroundings (Awad-Nuñez et. al, 2015).

At present, because of the growth of the volume of container transport (and its direct impact on ports), and consequently the issues of insufficient and incompatible infrastructures in seaports, dry ports have proven to be important nodes in transportation chain. Additionally, they have played a determining role in improving the efficiency of seaports. Therefore, the construction of a standard dry port can be a node for the change of transport modes as well as solution to the existing challenges of seaports.

Trade has grown sharply in the last decades. Total containerized trade volumes reached 16.8 percent or 1.69 billion tons), equivalent to 175 million twenty-foot equivalent units (TEUs) in 2015. The contribution of developing countries has been significant, as compared to the total volumes of international seaborne trade. Their contribution with regard to global goods loaded was estimated at 60 per cent, and their import demand, as measured by the volume of goods unloaded increased, reached 62 per cent (UNCTAD, 2015). It can be noted that, in recent years, the development of global container trade has significantly revolutionized the international transport. The role of dry ports in development of container transportation cannot be neglected, without which no nation could exploit the full potentials of containerization. This is because; dry ports create a centralized container service market for rail transportation within a country. Therefore, it can be urged that the development of national rail transportation and development of dry ports are interdependent (Jarzemskis & Vasiliauskas, 2007).

Cost reduction from qualified workforce, faster loading and unloading and fleet capacity growth take place along with changes in seaports. Larger ships naturally demand many changes to take place in ports including: deeper berths, wider basins, high capacity cargo handling systems, and so on., however, providing more port area behind the port apron is of prime importance. Containers do not require roofed storage, but they need sufficient space in hinterland for their commercial purposes as well as for stacking. Because of this requirement, the city ports have to move to new sites in less developed regions. Additionally, container trade has also caused relocation of industrial centers and workforce. Moreover, the most profound impact of the container is on the global economy as a whole. Containerization affects, not only the shipping industry, but local development, environment, culture and so on (Tamlinson, 2009; Broeze, 2002).

Tsao and Linh (2018) have used a non-linear optimization method (the continuous approximation model) to help in the design of seaport–dry-port networks and concluded that the development of dry ports and the use of multimodal transport, for example using rail transport, which is a greener type of transport than road, could reduce carbon costs.

A holistic approach to the development of the intermodal terminals raises a new concept of “dry port”, which can be defined as an intermodal terminal in hinterland connected to one or more seaports using a high capacity transport method (usually scheduled trains). These terminals are equipped with adequate cargo handling systems to accommodate the demands of different transportation modes, where customers can easily send and receive their cargoes. Industrial development and consequently increase in demand for maritime transport has caused the ports and their connections to grow accordingly (Arabshahi et al., 2010). The maritime transport is increasing the number of operations and the level of occupancy of their storage yard, triggering congestion in sea/river ports and consequently in dry ports (Hervás-Peralta et al., 2019).

A dry port is, in fact, an inland intermodal terminal directly connected to seaport(s) with high capacity transport mean(s) including road, rail and air, where customers can leave/pick up their standardized units as if directly to a seaport (Roso, 2007). Dry ports, not only, caused a reduction in road transport needs for seaports, but also have created the opportunities to transfer the activities causing congestion at seaport gates to inland terminals. Some of these activities include customs clearance, physical and security inspections and information handling; or transferring the container operations, such as loading, unloading and storage, in dry ports save a considerable amount of space in seaports (Jarzemskis & Vasiliauskas; 2007).

The concept of the dry ports, with a major shift of loads from road to rail, allows the seaports to find a market in the hinterland and without needing to develop, throughput of seaports can be increased, giving better services to ships and shippers. All these mean that the port cities and management of ports benefit from less road density and less infrastructure investment (Saeedi et al., 2011). Dry port is an intermodal inland terminal that requires necessary consideration for locating its accurate site, and being considered as the main domestic market responsible for attracting and distributing goods, and providing significant services (Mohammadi, 2004). Additionally, dry ports can be used as a centre to consolidate exported goods, as well as reducing the number of empty wagons or truck traffics. Consequently, increasing the size of shipment will reduce the total cost of transportation because of economies of scale (Sheikholeslami et al., 2011). In addition to the basic services of the cargo handling that any inland terminal offers, services, such as consolidation, stacking, empty containers storage, maintenance and repair of containers and customs clearance should be provided in dry ports. The quality of accessing a dry port and the quality of road, rail and maritime connections to a dry port determine the quality of the terminals' performance. Thus, a planned, reliable and high capacity transport is necessary to transfer the loads between seaports and dry ports. This means that dry ports are used more consciously than inland terminals, with the aim of improving the conditions through increasing container throughput and concentrating on security and control by information and communication systems (Saeedi et al., 2011).

Because of improvements in maritime transport industry, particularly the impacts of containerization, the ports are facing new challenges. The most important ones are the lack storage space and the lack of proper transport access to the hinterland. One of the solutions to overcome these problems is the constructing dry ports. Dry ports, not only, minimizes these issues, but also they are beneficial. The benefits include road traffic reduction, fuel consumption reduction, reduction in expropriation of port lands, etc. (Sheikholeslami et al., 2011). Dry ports can efficiently reduce the energy consumption, environmental impacts and pressures on seaports, as well as providing seaports with efficient ways of serving ships. Dry ports are divided into close, midrange, and distant dry ports (Roso et al., 2008; Saeedi et al., 2011).

Review of relevant literature proves that there has been a considerable number of empirical researches on the topic of dry port. Almost all researchers have emphasized the existence and importance of dry ports. The previous researchers have found effective factors on constructing dry ports, but these factors are scattered throughout the literature. That is, there is no consensus on important factors affecting the constructing dry ports. Therefore, by concentrating on the previous studies, this paper aims to identify and prioritise the effective factors in constructing dry ports. Initially, a list of effective factors on constructing dry ports will be extracted from literature. Secondly, a panel of expert will be asked to identify and group the most important factors. Thirdly, the identified factors will be grouped and presented in a hypothetical model. Then, a questionnaire will be used to collect the primary data. Finally, appropriate statistical tests will be used to analyze the collected data.

2. Material and Methods

By reviewing the literature, only 20 effective and most important factors on constructing dry ports were identified by panel of experts. Factors, such as intermodal inland terminal, access to main national and international trade routes (hinterland), necessary regulations and guidelines for constructing dry ports, customs and clearance services, global informational networks (Information and Communication Technologies) and so on. All factors in the analytical model are identified and classified into three groups of infrastructure, hardware and software (Mohammadi, 2004; Arabshahi et al., 2010; Sheikholeslami et al., 2011; Saeedi et al., 2011; Roso et al., 2006; Roso, 2007; Jarzemskis & Vasiliauskas, 2007; Roso et al., 2008; Roso & Lumsden, 2009; Trainaviciute, 2011; Henttu & Hilmola, 2011). Based on the identified factors and the proposed groups, an analytical model was hypothesized (Figure 1). It is assumed that 20 identified criteria (presented in three groups) are the most effective factors in constructing dry ports in Iran. It is also expected that there is a correlation between the infrastructure, hardware and software factors.

3. Result and Discussions

A panel of experts consisted of university professors and the experts in the Iranian Port and Maritime Organisation was formed for identification and grouping of the most important factors affecting the construction of dry port in Iran. The result of the expert panel was the identification of 20 factors, which were classified into three groups as followings:

Group 1. Infrastructure: Intermodal inland terminal, access to national and international main routes, The availability of lands around the port for developing and improving, lack of specific and protected habitats, proximity to production markets, need for a strong security system in dry port, access to borders, proximity to international supply chains and proximity to seaports.

Group 2. Hardware: Availability of the required equipment and vehicles, availability of equipment and facilities for loading and unloading, availability of warehouse, availability of tools for repair, maintenance and service, constructing container yard, access to empty container for commercial transactions, possibility of providing inexpensive labour force and possibility of providing expert labour force.

Group 3. Software: Providing the required regulations and guidelines for constructing dry port, providing the customs and clearance services, constructing the electronic and global information networks (information and communication technologies).

Based on these factors and the mentioned groups, a questionnaire was designed as an instrument for data collection. The first part of the questionnaire collected demographic information, while the second part dealt with questions regarding the identified factors and their respective groups.

Since the variables in this research are qualitative, the sample size is calculated by:

$$n = \frac{t_{\alpha}^2 \times p_q}{d^2}$$

Because P is considered as an attribute variable P=0.5, thus the maximum variance is Pq=0.25. Since the sample size is unknown, t value, with 95% confidence or 5% error, was set to 1.96. Thus, with allowable error rate of d=0.1, 96 was found as the sample size by the following equation (Mansour far, 2011).

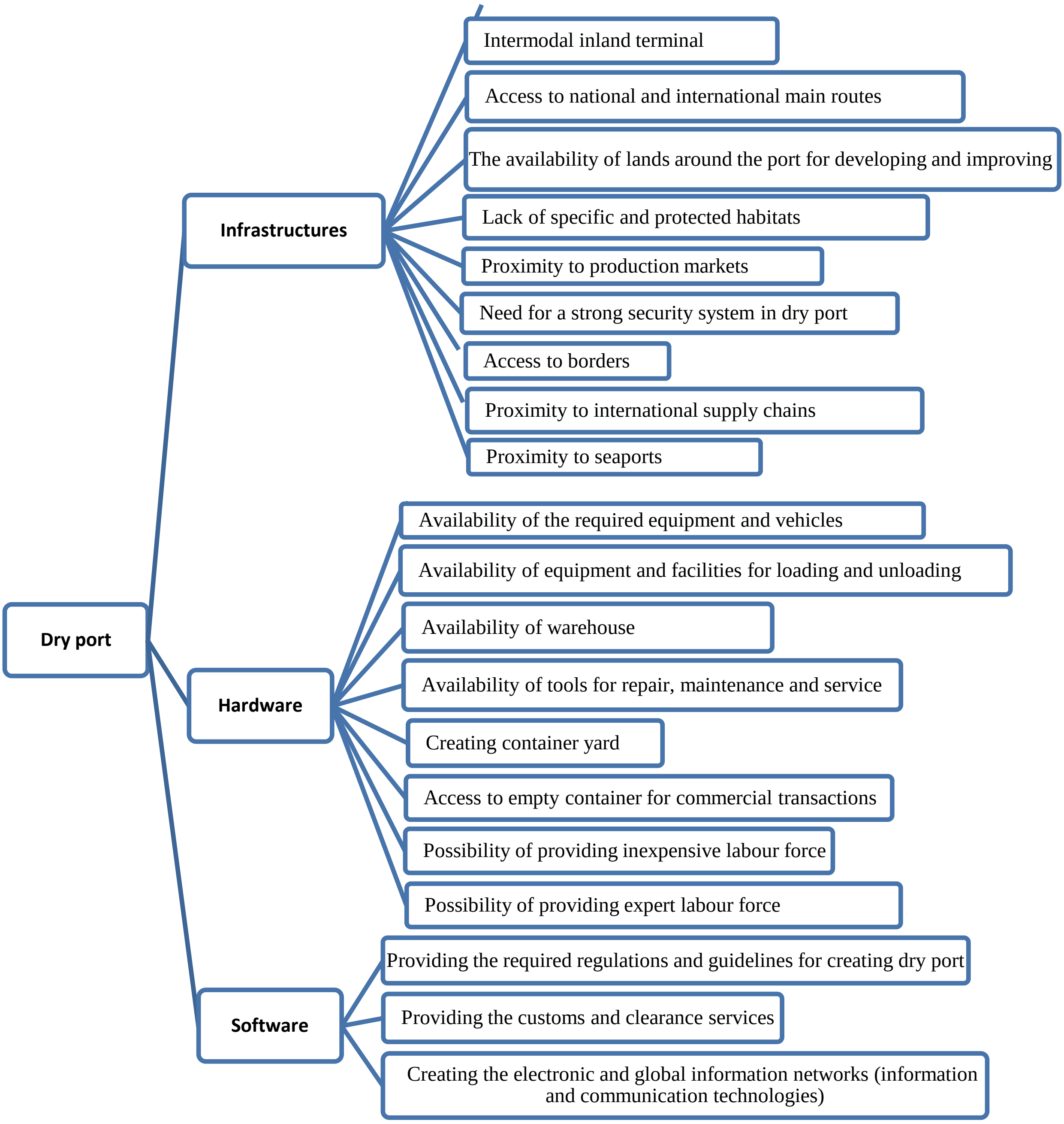

Fig 1: Analytical Model

$$n = \frac{(1.96)^2 \times (0.25)}{(0.1)^2} = 96 \qquad (1)$$

The validity of the questionnaire was approved by professionals in the field of ports and maritime transport. The reliability was also performed by Cronbach's alpha coefficient. Cronbach's alpha included all 20 factors of the questionnaire and found to be 0.789, which is within an acceptable range (Soleimanian & Jamshidi, 2005).

A total of 120 questionnaires were distributed among the target population and 108 completed questionnaires were returned (90% rate of return). The appropriateness of sample size and analysis suitability of collected data for further testing was examined by KMO[1] and Bartlett's test. KMO is a

[1] Kaiser-Meyer-Olkin: a measure of sampling adequacy test

measure of sampling adequacy test, and Bartlett's test determines to what extent the collected data are suitable for statistical analysis and their suitability for extracting logical results (Legendre & Borcard, 2005). The results showed the adequacy of sampling with KMO value of 0.659, which is acceptable because of its closeness to 1, and can be used for factor analysis. The significance level of Bartlett's test was less than 0.05 and acceptable.

Table 1 indicates another output of KMO and Bartlett's test for calculation of Goodness of Fit Index (GFI) for 20 identified factors and their respective groups. If the value for each factor is greater than 0.4, the factor will be considered appropriate. However, some empirical studies believe the values of greater than 0.3 can be accepted too (Legendre & Borcard, 2005).

Table 1: The Coefficient of the Factor Analysis of the Indices

Groups	Factors	Coefficient
1 **Infrastructure**	Intermodal inland terminal	0.538
	Access to the national and international main routes (hinterland)	0.615
	The availabilty of the lands around the port for developing and improving	0.573
	The lack of the specific and protected inhabitants	0.425
	Proximity to the production markets	0.624
	The need for a strong security system in dry port	0.634
	The access to the borders	0.411
	Proximity to international supply chains	0.467
	Proximity to the seaports	0.453
2 **Hardware**	The availability of the required equipment and vehicles	0.680
	The availability of the equipment and facilities for loading and unloading	0.740
	The availability of warehouses	0.720
	The availability of the tools for repair, maintenance and service	0.698
	Constructing container yard	0.786
	Access to the empty container for commercial transactions	0.870
	Possibility of providing inexpensive labour force	0.715
	Possibility of providing the expert labour force	0.740
3 **Software**	Providing the required regulations and guidelines for constructing dry port	0.650
	Providing the customs and clearance services	0.507
	Constructing the electronic services and global information networks (information and communication technologies)	0.542

The results in Table 1 indicate that the values of the factor analysis for all factors are higher than 0.4, which proves the suitability of all the identified factors. Accordingly, to determine the suitability of three groups of infrastructure, hardware and software, they were also subject to factor analysis. The results are shown in Table 2. Since, the three groups of infrastructure, hardware and software could gain factor analysis value of 0.4, they can be used as fundamental criteria for constructing dry ports in Iran.

Table 2: The Factor Analysis Coefficient

	Factor	Coefficient
1	Software	0.691
2	Hardware	0.565
3	Infrastructure	0.630

The first step in data analysis is to decide on the methods of statistical tests; namely, parametric or nonparametric tests (Moemeni & Faal Qayumi, 2012). In this respect, Kolmogorov-Smirnov (KS) test was utilised. The results of Kolmogorov-Smirnov (KS) test showed (Table 3) that the collected data were of nonparametric nature (the significance levels of all factors were less than 0.05).

Table 3: Kolmogorov – Smirnov Test (KS)

		Total Factors and Groups
Number of the Sample		108
Distribution parameters	Mean	4.1954
	Standard Deviation	0.57728
The Maximum Deviation	Absolute Value	0.268
	Positive	0.268
	Negative	-0.167
Z Test Statistics		2.790
Significance Level		0.000

Based on nature of data, nonparametric statistical tests such as Mann-Whitney test (U test) and Kruskal-Wallis Test (H test) were used to analyse the demographic data, and binomial distribution tests (success test), Spearman and Freidman correlation coefficients were carried out for analysis of the 20 identified factors and their respective groups for constructing dry ports in Iran.

3.1. Mann–Whitney U Test

Mann-Whitney U test is a non-parametric statistical technique. It is used to analyse differences between the medians of two data sets, or to compare differences between two independent groups when the dependent variable is either ordinal or continuous, but not normally distributed (De Vaus, 2002). In this research, therefore, this test was used to compare the answers (or reactions) of male (93 participants) and female (15 participants) respondents regarding the constructing dry ports. The results of this test (Table 4) proved that the significant level was 0.682. The significance level of more than 0.05 in Mann-Whitney U test is an indication of having no significant difference in the mean answers of females and males respondents.

Table 4: Results of Mann - Whitney U Test

Test	Coefficient
Mann-Whitney U Test	651.500
Wilcoxon W Test	771.500
Z Value	-0.409
Significant Level	0.682

3.2. Kruskal -Wallis H Test

The Kruskal-Wallis H test is a nonparametric (distribution free) test. It can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous or ordinal dependent variable (Yasubi, 2010). In this research, respondents' "department", "position", "experience" and "education" (academic degree) were compared by Kruskal-Wallis H test for possible significant differences (Yasubi, 2010). The results showed (Table 5) that "experience" and "education" scored significance levels of 0.000 and 0.029 respectively.

Table 5: Results of Kruskal-Wallis H Test

Respondents' Demographic Data	Test	Result
Experience	K2	20.315
	Freedom level	4.0
	Significance level	**0.000**
Department	K2	4.925
	Freedom level	2.0
	Significance level	**0.085**
Position	K2	2.111
	Freedom level	3.0
	Significance level	**0.550**
Education	K2	7.051
	Freedom level	2.0
	Significance level	**0.029**

The significance level of less than 0.05 in Kruskal-Wallis H test is an indication of having no significant difference in the mean answers of respondents with different experience and education levels. The results for "department" and "position" showed significance levels of 0.085 and 0.550 respectively, which were more than 0.05 and an indication of having no significance difference.

3.3. Binomial Distribution Test (Success Test)

The binomial test is a nonparametric test of binomially distributed hypotheses. Obviously, it is useful for testing hypotheses about binary random variables (e.g. a coin flip, success or failure on a test), but it can also be used to test hypotheses about the median of a population. In the present study, it was used for acceptance or rejection of hypotheses regarding identified factors of dry port creation. The hypotheses were:

H_0: the identified factor/group does not have any effect on constructing dry ports in Iran

H_1: the identified factor/group is effective on constructing dry ports in Iran

To confirm H0 and reject H1, the significance level should be more than 0.05. However, to confirm H1 and reject H0, the significance level should be less than 0.05 (Moemeni & Faal Qayumi, 2011). Consequently, three groups of infrastructure, hardware and software underwent binomial distribution test.

As tabulated in Table 6, the significance level of all three groups were obtained as 0.000 (less than 0.05), which proved that infrastructure, software and hardware are very effective for constructing dry ports in Iran.

Table 6: Binomial Distribution Test (Success Test)

Group		Range	Respondents	Observed Prop.	Test Prop.	Significance Level
Infrastructure	Group 1	3≤	2	0.0	0.6	0.000
	Group 2	3≥	106	1.0		
	Total		108	1.0		
Hardware	Group 1	3≤	0	0.0	0.6	0.000
	Group 2	3≥	108	1.0		
	Total		108	1.0		
Software	Group 1	3≤	0	0.0	0.6	0.000
	Group 2	3≥	108	1.0		
	Total		108	1.0		

3.4. Spearman correlation coefficient

Spearman correlation coefficient is a nonparametric measure of rank correlation. It assesses how well the relationship between two variables or factors can be described using a monotonic function. This coefficient is between +1 and -1; and if there is a lack of relationship between the variables, the coefficient will be equal to zero (Mirzaee, 2011). In this research, the following two hypotheses were considered:

H0 ($p=0$): there are no significant relationships among factors/groups effective on constructing dry ports

H1 ($p\neq 0$): there are significant relationships among factors/groups effective on constructing dry ports

Spearman test was carried out for three groups of infrastructure, hardware and software. The results of Spearman correlation and their corresponding significance levels for these groups are shown in table 7.

Table 7: Spearman Correlation Coefficients

Groups		Infrastructure	Hardware	Software
Infrastructure	Correlation	1.000	0.532	0.250
	Significance Level		0.000	0.009
	No.	108	108	108
Hardware	Correlation	0.532	1.000	0.404
	Significance Level	0.000		0.000
	No.	108	108	108
Software	Correlation	0.250	0.404	1.000
	Significance Level	0.009	0.000	
	No.	108	108	108

Based on the obtained results, the values of Spearman correlation coefficient confirmed that there were positive correlation between three groups of infrastructure, hardware and software. However, it was required to perform a significance test to decide whether based upon this sample there is any or no evidence to suggest that linear correlation was present in the population. Since all significance levels were less than 0.05, there was a very strong evidence to believe that the null hypothesis, H0, was rejected and H1 was confirmed. It could also be concluded that there was a high correlation between three groups. The highest correlation (0.532) existed between infrastructure and hardware groups; and the lowest correlation (0.250) existed between software and the infrastructure groups.

3.5. Friedman Test

In the present research, one of the main aims of this research is to prioritize the identified effective factors of dry port creation in Iran. In other words, the important factors should be prioritized to determine the factors that are having highest and lowest effect on constructing dry ports in Iran. Since, data are non-parametric, Friedman Test was used to prioritize the factors (Azar & Moemeni, 2008). The Friedman test is non-parametric and tests differences between groups when the dependent variable being measured is ordinal or continuous. This test was carried out for 20 identified factors (Table 8) and their respective groups (Table 9).

Table 8: Factor Prioritisation

	Factor	Mean Rank
1	The availability of the equipment and facilities for loading and unloading	15.00
2	Providing the customs and clearance services	14.34
3	Access to the national and international main routes (hinterland)	13.90
4	The availability of the required equipment and vehicles	13.88
5	Providing the required regulations and guidelines for constructing dry port	13.80
6	Constructing the electronic services and global information networks (information and communication technologies)	12.62
7	The availability of warehouses	11.84
8	Possibility of providing the expert labour force	11.80
9	The availabilty of the lands around the port for developing and improving	11.66
10	Constructing container yard	10.92
11	Intermodal inland terminal	10.54
12	Proximity to international supply chains	9.08
13	The availability of the tools for repair, maintenance and service	8.82
14	The lack of the specific and protected inhabitants	8.14
15	Proximity to the seaports	8.04
16	The need for a strong security system in dry port	7.98
17	Possibility of providing inexpensive labour force	7.42
18	Access to the empty container for commercial transactions	7.32
19	Proximity to the production markets	6.90
20	The access to the borders	6.00

In Table 8, because of the prioritization, it is clear that some factors are more important than others in constructing dry ports in Iran. Because of the obtained score of these indices by Friedman test, "the availability of the equipment and facilities for loading and unloading" scored the highest (15.00) and "the access to the borders" scored the lowest effect (6.00) on constructing dry ports in Iran.

As can be seen in Table 9, software with 2.80 scored as the most important factor in constructing dry ports. Hardware with 1.84 and infrastructure with 1.37 were ranked as the second and third important in constructing dry ports in Iran, respectively.

Table 9: Group Prioritisation

Group	Mean Rank
Software	2.80
Hardware	1.84
Infrastructure	1.37

4. Conclusions

Based on the findings of this research, it can be concluded that:

1. For constructing dry ports, provision of modern loading and unloading equipment is a necessity,
2. For constructing dry ports, an efficient and modern customs (electronic customs) organization is a prerequisite,
3. Establishing an efficient transportation system can facilitate the cargo movement and will reduce the storage costs in seaports,
4. Constructing electronic infrastructure to provide electronic services,
5. Dry ports are to be set up in areas where future (potential) developments are permitted,
6. Requiring a very strong and efficient management ,
7. Involving private section in dry ports can be effective,
8. Establishing careful regulations and guidelines can simplify and assist the creation process,
9. Publicizing and diffusion of the advantages of dry ports is essential,
10. Dry ports are to be built along the available transit corridor routes in the country,
11. Comparative studies to be carried out to learn from experiences of successful dry ports in other countries.

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