An Investigating the Impact of Infrastructure Network Quality on Competiveness Performance in Oman

Ali Mohsin Salim Ba Awain*[1,2], Mohd Dan Jantan[3]
Dhofar University Salalah, Sultane of Oman
Infrastructure University Kuala Lumpur (IUKL), Malaysia

Abstract

The concept of competitiveness has attracted the attention of practitioners and researchers from various perspectives. The infrastructure quality can generate competitiveness. The objective of this study is to assess the influence of infrastructure quality on competiveness. The target population is the 778 logistics service company in Oman. the sampling frame is a list of all the logistics services in Oman in the 5 key sectors which include air transport service, marine transport service, shipping and port agent, land transport, transport agent with total sample is 152. Regression analysis was deployed to investigate the relationship between infrastructure network quality, that consist of transport network infrastructure quality and energy network infrastructure quality on competiveness. The results of study showed that competitiveness is greatly influenced by quality of infrastructure, including transport network infrastructure and energy network infrastructure quality. The findings of this research help to explain what infrastructure allows to be more successful in raising competiveness.

Keywords: Infrastructure, competiveness, Transport, Energy, Oman

Introduction

Oman's national vision 2040 is the Sultanate's gateway to overcoming challenges, keeping up with regional and global changes, generating and exploiting opportunities to promote economic competitiveness and social well-being, stimulate growth, and build trust in all economic, social and national development relationships (Oman Vision 2040)

To achieve these national goals, Oman's economy requires a reliable transport network and energy network infrastructure quality to link supply chains and move goods and services efficiently across borders. Quality infrastructure connects households across the Oman region to improve competitive performance. Clean energy and public transport can reduce greenhouse gases. This same economic logic applies to broadband networks, water systems, and energy production and distribution.

The main purpose of this research in to investigate the linkage between infrastructure network and national competiveness performance of Oman.

Literature Review and Hypotheses

Infrastructure

The difference between infrastructure (e.g., transport network and energy network infrastructure) and superstructure (e.g., manufacturing, agriculture and mining) without aaccurate definition to these terms (Tinbergen (1962)

According to Jochimsen (1966) The idea of infrastructure bring up to the number of material, institutional and personal facilities and data available to economic agents and which contribute to realizing an even distribution of income for the population of a country resulting in an increase in competiveness.

The infrastructures are telecommunication, transport, energy and water (Kasper, 2015). Each of these infrastructures is grouped into several sectors as described in the following table.

Table 1: Taxonomy of the Definition of Infrastructure

Infrastructure	Networks Parts	Service	Sector
Telecommunication Infrastructure	Landline	Landline network, joints, receivers	Data communication
	Mobile	Mobile towers, mobile phones	Data transferal
	Broadcast	Satellite, broadcaster, TV-receiver, TVs	Data transferal
Transport Infrastructure	Rail	Station, track, control system	Merchandise and passengers transport
	Road	Streets, parking areas	Merchandise and lodger transport
	Air	Airport, control system	Merchandise and lodger transport
	Water	Ports, water street	Merchandise and voyager transport
Energy Infrastructure	Electricity	Power plant, joints, transmission line, plug socket	Generation and electricity transfer
	Oil	Oil rig, pipeline, storage	Exploitation, generation and processing and transport of oil
	Gas	Oil rig, pipeline, storage	Exploitation, generation and processing and transport of gas
Water Infrastructure	Fresh water	Fresh water side (well), pipeline	Fresh water exploitation, transport of water
	Waste water	Waste water recycling, pipeline	Transport of waste water, treatment of waste water

Source: (Kasper, 2015)

Infrastructure classification

According to ISTAT (2006) infrastructure can be grouped into ten main categories, namely (1) economic infrastructure, (2) core infrastructure, (3) basic infrastructure, (4) material infrastructure, (5) network infrastructure, (6) social infrastructure. (7) non-core infrastructure, (8) complementary infrastructure, (9) immaterial infrastructure and (10) core infrastructure. Summary of infrastructure classification described in Table 2.

Table 2: Infrastructure classification

Hansen (1965)	Aschauer (1989)	Sturm, Jacobs et al. (1995)	Di Palma, Mazziotta et al. (1998)	Biehl (1991)
Economic Infrastructure	**Core Infrastructure**	**Basic (main) Infrastructure**	**Material Infrastructure**	**Network Infrastructure**
Roads	Roads	Main railways	Transport network	
Highways	Highways	Main roads	Water system	Roads
Airports	Airports	Canal	Energy network	Railways
Naval transports	Public transport	Harbours and docks		Water highways
Sewer network	Electricity network	Electromagnetic telegraph		Networks of communication
Aqueduct network for water distribution	Gas network	Drainage dikes		System for energy and water provisioning
Gas network	Network for water distribution	Land reclamation		
Electricity network	Sewer network			
Irrigation plant				
Structure dedicated to commodities transfer				
Social Infrastructure	**Not-core Infrastructure**	**Complementary Infrastructure**	**Immaterial Infrastructure**	**Nucleus Infrastructure**
Schools	Residual components	Light railways	Structures dedicated to development, innovation and education	Schools
Structure for public safety		Tramways		Hospital
Council flat		Gas network		museum
Plant for waste disposal		Electricity network		
hospitals		Water supply		
Sport structurer		Local telephone networks		
Green areas				

Source: ISTAT (2006)

Buhr (2003) also classifies infrastructure into two main categories: (1) physical needs which include water, gas, oil, electricity, medical care, waste water disposal, accommodation and flood protection, (2) social needs which include security, information, education, mobility and environmental protection. The summary of material infrastructure to fulfill human life is described in Table 3.

Table 3: Material infrastructure to satisfy requirements of human life

Want	Infrastructure out (goods or services)	Material infrastructure
Physical requirement		
Water	Drinking water, industrial water, irrigation water, hydro electric power	Reservoirs, canals, waterways, pipes, irrigation facilities.
Warmth	Gas, oil, electricity, coal, nuclear energy	Drilling platforms, pipelines, generation plant, coal mines
Light	Electricity, gas	Generation plants, drilling plants, circuits, pipelines
Health	Medical care, refuse collection, waste water disposal	Hospitals, dumps, sewerage system
Protection against nature shelter	Accommodation working places, flood protection	Houses, building, plant levees
Social requirements		
Security	Legislation (law), judicial, stability of the value of money, protection against crime, external defense, military goods	Public buildings, police station, military installations
Information	Use of telephones, mobile phones, radio, television, internet, newspapers	Telecommunication facilities, post office, newspapers production works
Education	Childcare, lectures, research, lending books	Kindergarten, schools, universities, research institutions, libraries
mobility	Road use by cars, buses, trucks	Road, highways
	Use of tracks by train	Track, train station
	Use of airports by airplanes	Airports
	Use of port by ships	Ports
Environmental protection	Clean air and water	Air purification filter, waterworks

Source: Buhr (2003).

Volpe (2007) also classified infrastructure based on macro sector and regional public account (RPA) category that consists of the following (1) economic infrastructure, (2) Human capital infrastructure, social infrastructure and (4) residential building infrastructure. The summary of macro sectors depicted in Table 4.

Table 4: Macro-sectors and regional public accountant (RPA) sectors

Economic infrastructures	Roads Other transportation Telecommunication environment Waste disposal Water Sewer energy and water treatment Agriculture Fisheries and aquaculture Industry and craftsmen Wholesale and retail distribution Tourism Other public works Other economic sectors
Human capital	Education Training Research and development Pensions and wage supplementation Labour
Social infrastructure	Culture and recreational services Health Other social affairs (assistance and charity) Other health and sanitation Defenses Public order Justice General administration Unclassified expenditure
Residential building	Residential building

Source: Volpe (2007)

Furthermore, ISTAT (2006) classified infrastructure based on macro area and sub area. According to this category, infrastructure classified as follows: (1) economic infrastructure, (2) social infrastructure and (3) territory infrastructure. The summary of this category summarized in Table 5.This research focus on economic infrastructure, social infrastructure and territorial infrastructure as independent variable.

Table 5: Infrastructure classification according to macro-area and sub-area

Economic infrastructures		**Social Infrastructures**		**Territory Infrastructures**	
Transport Network	road Transport railway Transport air Transport sea Transport other aspects	Health Infrastructures	free hospital treatment health service social security Other aspects	Tourist infrastructures	Tourist receptiveness other aspects
Energy Network	electricity network gas Network water-system other aspects	Educational Infrastructures	nursery primary school for pupils aged 11 – 14 secondary school compulsory education University other aspects	Trade Infrastructures	Retail trade Wholesale trade Other aspects
		Culture Infrastructures	Cultural, artistic and historic heritage Theatre, music, cinema and entertainment Sport other aspects	Monetary intermediation Infrastructures	Monetary intermediation
		Environmental Infrastructures	Water purification plant Waste disposal Green areas Other aspects		

Source: ISTAT (2006)

Competiveness Performance

The ability of a company to make products and services is one of the most important dimensions of competitiveness. competitiveness means reaching internal commodities and services into the market. Competitiveness is also defined as the ability of an economy to stabilize its market share (Karimi-Hesenijeh, Hossein, 2007).

A comprehensive approach to competitiveness was first developed by Michael Porter called the diamond model (Porter, 1990). Then Porter's diamond model was expanded into two, namely (1) the incorporation of multinational activities through the introduction of the double diamond model (Rugman 1991 Moon, Rugman and Verbeke 1998, Dunning 2003) and (2) the addition of the role of human factors through the proposed nine-factor model (Cho, 1994).

Figure 1 describes the four groups of human factors and the four physical factors of the real diamond model. Human factors and physical factors interact with each other in order to spur the development of a nation. Human factors include workers, politicians and bureaucrats, entrepreneurs and professionals (including scientists and managers). Physical factors include factor conditions, demand conditions, related and supporting industries and business contexts. External factors, added to these eight internal factors to create a new paradigm.

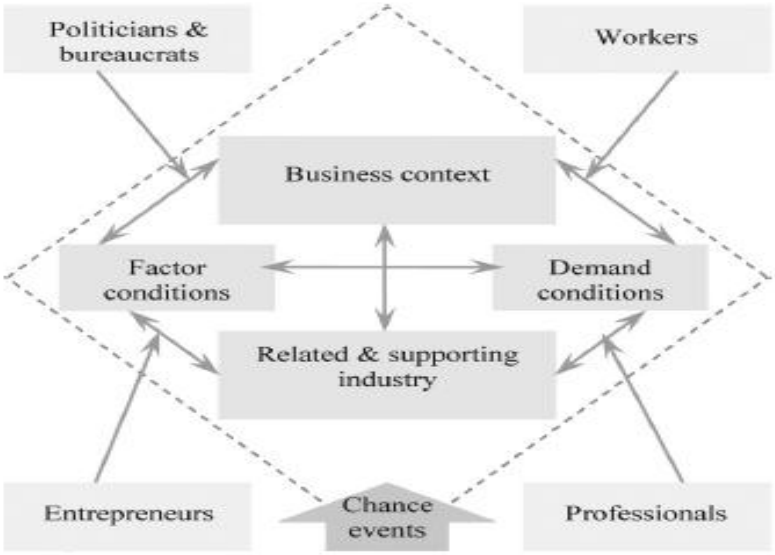

Figure 1: The "Nine-factor" model (Cho 1994)

Conceptual competitiveness has been developed by Buckley et al. (1998) emphasizes the multidimensional and dynamic aspects. reflect recent, and past performance, but also more dynamic elements, such as the company's management processes and strategies to maintain its competitiveness. Buckley et al. (1998) and DC (2001) emphasize that competitiveness relates to "the combination of assets and processes, by which assets are inherited or created and the process of transforming assets to achieve economic benefits from selling to customers" (DC, 2001). The literature describes competitiveness through a competency approach that can be approached with a resource-based approach. Many authors emphasize the superior role of companies such as strategy, structure, efficiency, ability to innovate, and other tangible and intangible resources for their competitive success (Bartlett and Ghoshal, 1989; Doz and Prahalad, 1987; Hamel and Prahalad, 1989, 1990; Peteraf, 1993; Ulrich, 1993). The company's ability to develop, expand, and use capabilities more effectively than its competitors is at the root of competitiveness (Smith, 1995). Dynamic ability, flexibility, agility, speed, and adaptability are increasingly emphasized as determinants of a company's competitiveness (Barney, 2006; Sushil, 2000).

Similar to Buckley et al. (1998), in this paper, the concept of competitiveness is divided into three main dimensions: competitive performance, competitive potential, and assertiveness that are relevant to competitiveness. Competitive performance measures a company's past and current performance in the market. The competitive potential of a company is related to internal factors that can determine the company's competitive performance in the future. A company's capabilities are the key to translating its competitive potential into actual or future performance. However, the research focuses more on the performance of competitiveness in relation to the quality of infrastructure, both network infrastructure and energy network infrastructure.

Table 6 describe the conceptual model for competiveness. According to European economic research (2018) there are three model for competiveness, namely (1) competitive potential, (2) competitive performance and (3) external factors. This research more focus on investigating the infrastructure quality on competitive performance (Volpe, 2007)

Table 6: Conceptual model for competiveness

Competitive potential	Competitive performance	External factors
Product innovation	Market share	Institutions
In house cost efficiency	Export share	regulations
Supply side cost efficiency	Profit margin	Infrastructure
productivity	Return on capital	education
	Survival	Labor market
	growth	Financial market
	productivity	technologies
		Policies

Sources: Center for European Economic Research (2018)

Measuring the infrastructure and national competiveness

The items and source of the infrastructure and national competiveness instruments are presented in the Table 7.

Table 7. Items and source of the instruments

Variables	Sub Variables	Items	Source
Economic Infrastructure	Transport network	Road transport	(ISTAT, 2006)
		Railway transport	
		Air transport	
		Sea transport	
	Energy network	Electricity network	
		Gas network	
		Water system	
Competiveness	Competitive performance	Market share	Center for European Economic Research (2018)
		Export share	
		Profit margin	
		Return on capital	
		Survival	
		Growth	
		Productivity	

The relationship between infrastructure and competiveness Performance

Many studies have been conducted on the influence of infrastructure on macroeconomic productivity (Ratner, 1983, Mitsui, K. & J. Inoue, 1995, Aschauer, 1989, Snieska, V. & I. Simkunaite, 2009, Yoshino, N. and N. Masaki, 1999, Rohollah et al., 2013) All of these studies found infrastructure to be an effective productivity factor. The availability of transport network and energy network infrastructure services greatly influences the improvement of competitive performance. This is the reason why the level and quality of infrastructure has a direct effect on productivity and business growth. The impact of infrastructure quality on the development of company competitiveness is an important issue for strategic policy management. However, competitiveness has become a fundamental force in economic growth. From a macro-policy perspective, the main objective of competitiveness is the welfare of the citizens of a country, whether through individual income, standard of living, human development, or social justice (Kovacˇic, A., 2007). Therefore, this study aims to explore how infrastructure quality impacts competitiveness performance.

Theoretical analysis of the impact of quality infrastructure on producer competitiveness can be stated as follows: (1) Infrastructure allows business actors to generate additional production capacity, reducing input costs in production and transaction costs, (2) Infrastructure increases worker productivity, (3) Impact of infrastructure on growth economy, (4) Infrastructure also has a positive impact on education and health, (5) Infrastructure contributes to the accessibility of the poor and disadvantaged areas to core business activities, public communication, which can increase the value of their assets, and increase human capital (Tatyana Palei, 2014). Therefore, an in-depth study of the quality and competitiveness of infrastructure is needed to find out how the quality of infrastructure has an impact on the competitiveness of performance.

Siti and Tri (2021) find that the development of quality infrastructure is evidence of this development. The quality of infrastructure affects competitiveness. Infrastructure is not only needed to increase competitiveness but also to accelerate equitable development so that poverty and unemployment rates can be reduced.

According to ISTAT (2006), infrastructure can be classified into (1) Economic infrastructure which consists of (a) transportation network which includes road transportation, rail transportation, air transportation and sea transportation, (b) energy network other than electricity network, gas network, and water management, (c) health infrastructure consisting of hospital care, health services and social security, (d) educational infrastructure consisting of nurseries, primary schools, secondary schools and universities (2) Social infrastructure and (3) Infrastructure Areas . However, this study focuses on economic infrastructure consisting of transportation network infrastructure and the quality of energy network infrastructure on competitive performance.

Hypotheses

H1: Transport network infrastructure quality has a significant impact on competiveness performance.

H2: Energy network infrastructure quality has a significant impact on competiveness performance.

Study Framework

After examining various studies from previous studies, a research framework can be proposed as shown in Figure 2

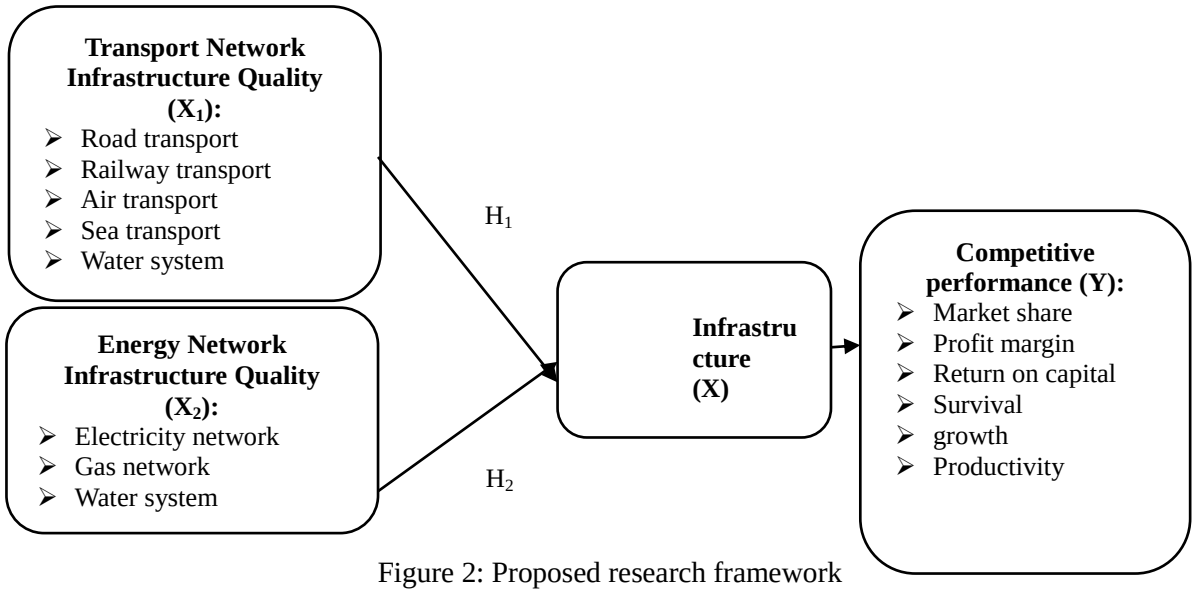

Figure 2: Proposed research framework

2. Methodology

Population and Sample

The total population of this research was 778 logistics service company in Oman. This research focus on 5 key sectors which include: air transport service, marine transport service, shipping and port agent, Land transport, transport agent. Sample size was drawn from 778 by using stratified random sampling

Table 8: Sample size

Logistics service listing by sector	No. of Logistics service company	formula	Strata sample	Stratum percentage
Air transport service	72	152*72/788	14	9%
Marine transport service	181	152*181/788	35	23%
Shipping and port agent service	184	152*184/788	36	23%
Land Transport service	275	152*275/788	53	36%
Transport agent service	76	152*76/788	14	9%
Total	788		152	100%

Regression analysis

To estimate the expectation of the competiveness (dependent variable) given the quality of infrastructure (independent variable), regression analysis was deployed. Competiveness as dependent variables are (1) competitive performance. Infrastructure was considered as independent variables are (1) transport network infrastructure quality (X1) that consists of road transport quality (X11), railway transport quality (X12), air transport quality (X13), sea transport quality (X14) and (2) energy network infrastructure quality that consists of electricity network infrastructure (X21), gas network infrastructure (X22), water system network infrastructure (X23). The railway transport quality was not measure in this research because railways transport is not available in Oman.

Y = a + b x1(X11, X13, X14) +bx2(X21, X22, X213

Y = Overall competiveness
X = Infrastructure quality
X1= Transport network infrastructure quality
X2 = Energy network infrastructure quality

Results

Descriptive statistics and Correlations

The survey involved the logistics services in Oman in the 5 key sectors which include: (1) air transport service, (2) marine transport service, (3) shipping and port agent, (4) Land transport, (5) transport agent. A survey has been carried out 152 respondents from different institutions in logistics field of Oman and only 80% (122) of questionnaire were returned (77.86%), 95 answered are usable from 122 which were returned by respondent and 19.73% (30) questionnaire copies were not returned. (see Table 9).

Table 9: Response Rate

Questionnaire distributed	152
Questionnaire collected	122
Collected respondent rate	80.26%
Usable questionnaire	95
Usable return rate	77.86%

Source: research survey

Mean for the two composite independent variables are 100.7053 for transport network infrastructure quality, 30.1368 for energy network infrastructure quality respectively, with corresponding standard deviation (SD) of 14.25518 and 5.52886 respectively. Means of one dependent variable, competiveness was 30.8947

Table 10: Descriptive statistics of infrastructure quality and national competiveness

	N	Min	Max	Mean	S.D
Transport network infrastructure quality	95	35	115	100.7053	14.25518
Energy network infrastructure quality	95	7	35	30.1368	5.52886
National competiveness	95	11	35	30.8947	4.88698

Factors that influence the variance (VIF) were calculated to check the levels of multicollinearity. The decision was made based on tolerance value; if tolerance value more than 0.10 (no multicollinearity), if tolerance value less than 0.10 (serious multicollinearity). The VIF in this model has transport network infrastructure quality (0.218), energy network infrastructure quality (0.204). All tolerance value infrastructure and competiveness indicated no serious multicollinearity.

Table 5showed the correlation between independent (transport network infrastructure quality and energy network infrastructure quality) was positive. Transport network infrastructure quality had a correlation of 0.832, $p<0.01$ with competiveness, energy network infrastructure quality had a correlation of 0.765, $p<0.01$ with competiveness, which mean that the respondents are more likely to evaluate transport network infrastructure quality, energy network infrastructure quality and competiveness rated positively.

Table 11: The correlation between infrastructure quality and national competiveness

	1	2	3
Transport infrastructure quality	1		
Energy network infrastructure quality	0.765 **	1	
Competiveness performance	0.853 **	0.864 **	1

Regression Result

When testing the statistical significance of the regression coefficients null hypothesis was rejected by one factors – railway transport network quality, the remainder were statistically significant and included in the regression equation. As a result, regression function of the impact of transportation network quality and energy network infrastructure quality on the competitiveness performance has R2=97%:

$Y = 0.21X11+0.17X13+0.18X14+0.15X21+0.14X22+0.12X23$

The impact of infrastructure on competitiveness can be concluded that the impact of infrastructure is expressed as follows: (1) transport network and energy network infrastructure enables businesses to market share, profit margin, return on investment, survival, growth and productivity; (2) Infrastructure increases the productivity of workers.

Conclusion

The results show that statistically significant positive relationship between transport infrastructure quality, energy network infrastructure quality on competiveness. These results appear to confirm (H1, H2)

H1: Transport network infrastructure quality has a significant impact on competiveness performance, H2: Energy network infrastructure quality has a significant impact on competiveness performance. These result suggest that to improve the competiveness, the transport network and energy network infrastructure quality need to improve.

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