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Correlation between Technological Readiness and Business Sophistication in Global Competitiveness

Gama Harta Nugraha Nur Rahayu [1]

[1] Faculty Member, Industrial Engineering Department,
Universitas Pancasila, Jakarta, Indonesia
E-mail: gama@univpancasila.ac.id
Tel: +6281223666610

Abstract

Country or nation's competitiveness has an important role in bringing the country to prosperity and an honourable position among other countries in the world. That is what has happened over the last decade, scholars, policymakers and even business leaders around the world have taken the issue very seriously. Since 1979, the World Economic Forum has published a Global Competitiveness Report which includes the Global Competitiveness Index (GCI) to measure national competitiveness in various countries around the world. Using two sets of variables "Technology Readiness" and "Business Sophistication" as the two basic pillars of national competitiveness, this study aims to interact between the two pillars to help countries transitioning from development stage II (efficiency-based development) to development stage III (innovation-based development) by providing useful information for increasing national competitiveness. This study uses a descriptive-free methodology. Based on the 2010 GCI report covering population statistics from 139 countries, a secondary analysis using Canonical Correlation Analysis was carried out. The results showed that there was a significant and positive relationship between the set of variables "Technology Readiness" and "Business Sophistication".

Keywords: ***Business sophistication; Canonical correlation analysis; Global Competitiveness Index; Technological readiness.***

1. Introduction

In a world of increasingly global competition, the intensity of economic competition between countries and between companies has increased immensely and become the main characteristic of the dynamics of the world economy. The concept of competitiveness has been further developed by Michael Porter from the sphere of the competitiveness of companies and industries to the sphere of national and global competitiveness (Porter and Schwab, 2008). In the view of the Organization for Economic Cooperation and Development (OECD), the capacity of a country to produce goods and services for sale on international markets is one of the tremendous important dimensions of competitiveness. In this connection, competitiveness means the ability to achieve a constant and decent position of a country's product in the international market (Karimi-Hesenijeh, 2007). Today, the level of economic development of a country depends on their ability in the political, national and economic spheres. Hence, a precise identification of the globalization process and proper monitoring of this trend is required in various countries, especially among developing countries that have entered this situation (Safari and Asgharizadeh, 2008). Countries, companies and industry organizations have confirmed the relation between innovation and economic success. Technological developments help innovators move to the forefront of market leaders. Therefore, the application of technology (in addition to its development) is one of the determining factors of success in global competition (Khalil, 1999). The state has a determining role to play in this process. It also means that more serious efforts are needed in education process and science reform, to promote cut-edge technologies and to amplify the private sector (Ivaniashvili-Orbeliani, 2009). The economic management agenda in many countries throughout the world is a process of transitioning the stages of economic development from an

efficiency-based economy to an innovation-based economy. For this reason, the formulation of a country's economic policy must support valid objectives and indicators at this transitional stage. The use of a comparative approach and benchmarking techniques upon the successful experiences of various countries around the world can help policy makers and business leaders in a country manage the economy and gain higher levels of prosperity. Hence, increasing national competitiveness is a determining factor (Vares et al., 2011). However, before embracing the GCI as a benchmark or before spending various resources and efforts, policy makers of a country must determine their country's priorities in order to level up national competitiveness. In this study, the authors try to provide information to countries that are on the way to experiencing a transition from an efficiency-based economic development stage towards an innovation-based economic development stage.

2. Literature Review

2.1. Competitiveness

There are three levels of competitiveness: company, industry and country (McFetridge, 1995). In this context, Porter (1990) believes that "the only proper definition of competitiveness at the country level is state productivity". Furthermore, Heap (2007) shows that "increasing productivity is the only way to 'bake the bigger cake', whereas other forms of policies only give us smaller 'slices of cake'. From a macro policy perspective, the main objective of competitiveness is the welfare of citizens, both in the form of personal income, living standards, human development, and social justice (Kovacic, 2007). In the current perspective, competitiveness has become a fundamental force in economics and the force of gravity in physics (Dutta, 2007). Competitiveness is a concept that tries to explain why some countries are capable of developing faster than others. In addition, competitiveness also links the macro and micro-economic conditions of a socio-economic development (Kovacic, 2007).

2.2. Measurement of the Competitiveness of a Country

The World Economic Forum (WEF)'s annual Global Competitiveness Report, since 1979, has examined the many factors that enable a national economy to attain sustainable economic growth and long-term prosperity. In this report, competitiveness has been defined as a set of institutions, policies, and factors that determine the level of productivity of a country (Porter & Schwab, 2008). Since 2005, the WEF has used the Global Competitiveness Index (GCI) as the basis for its competitiveness analysis. As a very comprehensive index, the GCI captures the microeconomic and macroeconomic foundations of a country's competitiveness. According to the GCI report, "the level of competitiveness of a country reflects the extent to which it is able to provide increased welfare for its citizens" (Schwab, 2009). GCI shows the parameters of measuring competitiveness by providing a weighted average of many different variables, each of which reflects one aspect of the complex concept of competitiveness (Schwab, 2009). Table 1 below classifies the GCI 12 (twelve) pillars:

Table 1. GCI pillars

Main Index	GCI Pillars
Basic requirements	• Institutions • Infrastructure • Macroeconomic environment • Health and primary education
Efficiency enhancers	• Higher education and training • Goods market efficiency • Labor market efficiency • Financial market development • Technological readiness • Market size
Innovation and sophistication factors	• Business sophistication • Innovation

The twelve pillars above do not stand alone from each other, but they all tend to reinforce each other, and shortcomings in one pillar often have a negative impact on the other pillars. For instance, innovation (pillar 12) will be extremely difficult without educated and well-trained workforce (pillars 4 and 5) who are expert at absorbing new technology (pillar 9). And innovation itself will also be very difficult if there is not enough money (pillar 8) for R&D (Schwab, 2010).

Table 2. Some of the previous studies that discussed on GCI issue

Author(s)	Topic
Vares, H., Parvandi, Y., Ghasemi, R. dan Abdullahi, B. (2011a)	This study examines the interdependence relationship between efficiency enhancers and innovation & sophistication factors in global competitiveness
Vares, H. dan Parvandi, Y. (2011b)	This research analysed underdeveloped countries' basic requirements for competitiveness.
Jafarnejad, A., Ghasemi, R., Abdullahi, B. dan Esmailzadeh, A. (2013)	They studied relationship between macroeconomic environment and technological readiness
Razavi, S. M, Abdullahi, B., Ghasemi, R., Shafie, H. (2012)	This study revealed relation between innovation and business sophistication in global competitiveness
Rastegar, A.A., Mahbanooei, B., Ghasemi, R.	This research studied relationship between technological readiness and labor market efficiency

Based on Table 2, there are several previous studies that discussed the issue of GCI, not including the relationship between technology readiness and business sophistication in global competitiveness. This study seeks to examine these problems so that more information can be contributed.

2.3. Three Stages of National Economic Development

Another thing that is useful from the GCI report is about the three different stages of national economic development held by various countries which indicate the level of their national economy.

Table 3. Stages of National Economic Development of a Country (Schwab, 2009)

Index	Stages of Development				
	Stage 1: Factor-driven	Transition from stage 1 to stage 2	Stage 2: Efficiency-driven	Transition from stage 2 to stage 3	Stage 3: Innovation-driven
GDP per capita (US$) thresholds	< 2,000	2,000-2,999	3,000-8,999	9,000-17,000	> 17,000
Weight for basic requirements subindex	60%	40-60%	40%	20-40%	20%
Weight for efficiency enhancers subindex	35%	35-50%	50%	50%	50%
Weight for innovation and sophistication factors	5%	5-10%	10%	10-30%	30%

In line with the theory of economic development, GCI classifies the stages of a country's national economic development into three stages: First, a factor-driven economy which is characterized by competitiveness that rests on ownership of natural resources and a less skilled workforce; Second, an economy based on efficiency factors (efficiency-driven) which is characterized by competitiveness that rests on more efficient production processes and higher quality products as well as skilled and high-wage labor; Third, an innovation-driven economy which is characterized by competitiveness that rests on high technology production processes and unique quality products and a highly educated and skilled workforce (Schwab, 2010).

2.4. Technological Readiness

In today's globalized world, technology is increasingly becoming an important element for companies to compete and achieve prosperity. The pillar of "Technological Readiness" measures the agility of a national economy (country) in adopting existing technology to increase industrial productivity, with particular emphasis on its capacity to fully utilize information and communication technology (ICT) in its daily activities as well as in the production process to increase efficiency and competitiveness. Technology is a factor of wealth creation. The more effective use of technology will greatly affect the competitive conditions. Technology management encourages discovery and innovation management, where these two things are the most important parts of any system of technology creation and utilization (Khalil, 1999).

The issue of whether the technology used has been developed domestically or not is certainly not a problem, because it is not directly related to the country's ability to increase productivity. The important thing is that companies operating in the country have access to sophisticated products and concepts and have the ability to use them (Schwab, 2010). The "Technological Readiness" pillar consists of six variables: Availability of the latest technology; Absorption of technology by companies; PMA and technology transfer; Internet user; Broadband internet subscribers; and Internet broadband (Porter & Schwab, 2008).

2.5. Business Sophistication

Business sophistication is very supportive of the realization of higher efficiency in the production of goods and services. This, in turn, can increase productivity, thereby increasing the competitiveness of a country. Business sophistication concerns the quality of a country's business network as a whole as well as the quality of operations and strategies of the companies that are in it. This is very important for countries with advanced economic levels, where it is almost impossible to improve natural-based production sources. Researchers believe that there is mutual agreement about the importance of the rate of technological change in determining the rate of economic growth (Feldman, 1999). On the other hand, the variability of competition rules in the business world indicates a special importance in the process of launching new products into the market. Today, more than ever, many organizations have realized that it is not enough to depend on traditional competitive forces such as increased quality, reduced costs or differentiation in the delivery of products and services, but on concepts such as speed and flexibility in competition. On the contrary, it tends to be more developed and the trend of attention to the launch of new products and services to the market itself is sufficient reason for this change in attitude (Jafarnejad et al., 2013).

The quality of a country's business network and its supporting industries, which can be measured by the quantity and quality of its local suppliers and their level of interaction, is important for a variety of reasons. When firms and their suppliers from a particular sector relate to each other in clusters of adjacent areas (clusters), efficiency will increase, greater opportunities for innovation will be created, and entry barriers for new firms will be reduced. The operations and strategies of the company (related to branding, marketing, value chain presence, and the production of unique and sophisticated goods) all lead to sophisticated and modern business processes (Schwab, 2010). The competitiveness pillar of "Business Sophistication" consists of nine variables: Quantity of local suppliers; Quality of local suppliers; Cluster development status; Characteristics of competitive advantage; Value chain length; Mastery of distribution abroad; Sophisticated production process; Marketing scope; Delegation of authority (Porter and Schwab, 2008).

2.6. Proposed Model

The proposed model consists of two sets (sets) of variables from two pillars of competitiveness, namely the pillar of "Technological Readiness" and the pillar of "Business Sophistication" as shown in the Figure 1. This paper is based on a hypothetical idea as the author’s standing point that all the pillars of competitiveness in the GCI are not independent of each other, but they all tend to reinforce one another. In this regard, there should be a meaningful relationship between "Technological Readiness" and "Business Sophistication" in the global competitiveness that will provide good understanding for decision and policy making. Starting from this main

hypothesis, the derivative hypotheses include: First, there is a correlation between the "Technological Readiness" variables and the "Business Sophistication" variables; Second, within the "Technological Readiness" variable group, there must be variables that have highest and lowest impact on creating a meaningful relationship between the pillars of "Technological Readiness" and "Business Sophistication"; Third, in the "Business Sophistication" variable group, there must be variables that have highest or lowest impact on creating a meaningful relationship between the pillars of "Technological Readiness" and "Business Sophistication".

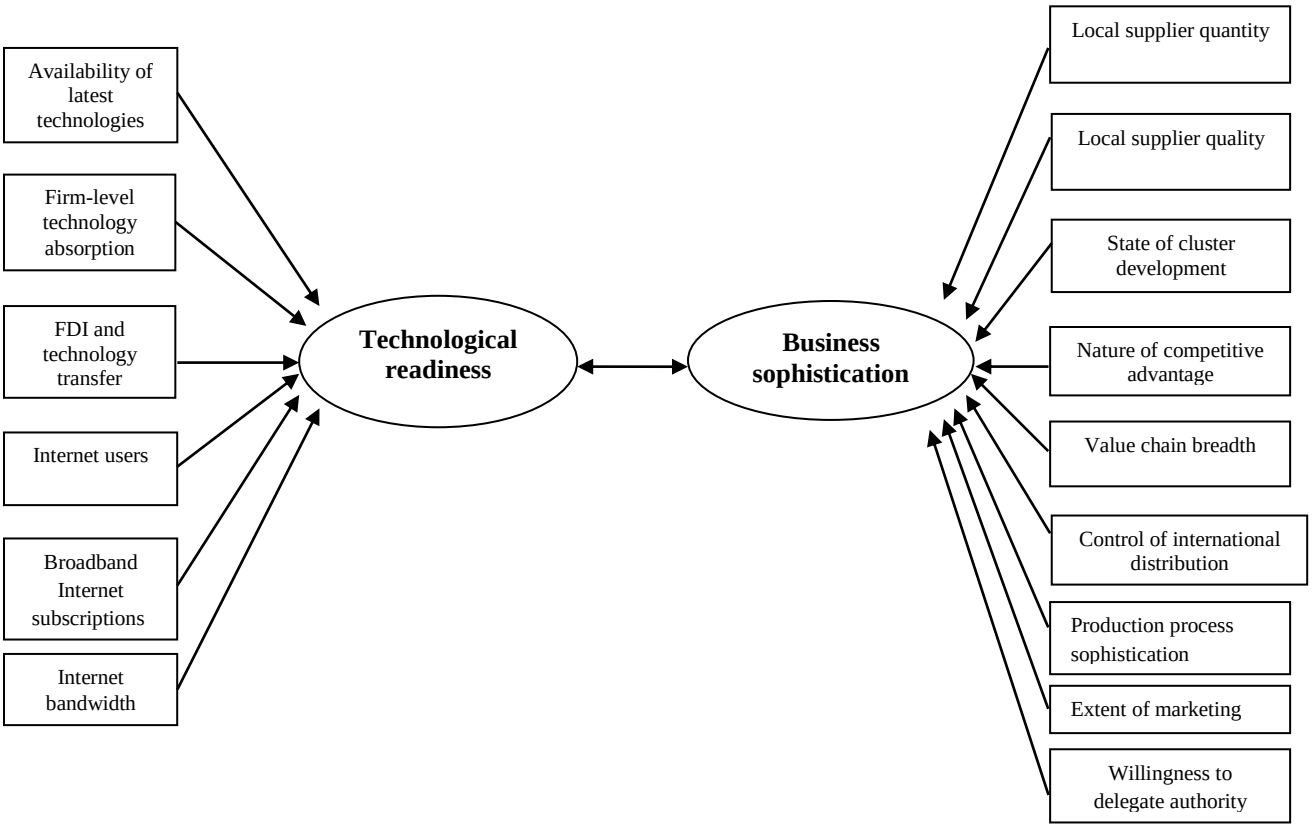

Figure 1. Proposed Research Model

3. Research method

The research method carried out for this research is correlative-descriptive. Secondary analysis methods are also conducted to analyse secondary data sources. As previously mentioned in the Introduction section, this study aims to investigate the interaction between the pillars of "Technological Readiness" and "Business Sophistication" in the GCI report in order to provide information to countries that are experiencing a transition from economic development level II to economic development level III for increase their national competitiveness in an efficient manner. In doing so, the author first conducts literature studies related to "Competitiveness", "GCI", "Technological Readiness", and "Business Sophistication". And since the proposed-model structure shows a correlation structure between two sets of variables, and based on the previous studies previously mentioned, the author proceeded with study on Canonical Correlation Analysis (CCA). Furthermore, the authors used "CCA" using SAS9 software; and after that, the results of the analysis were obtained.

3.1. Canonical Correlation Analysis

Canonical Correlation Analysis (CCA) is a multivariate statistical approach for measuring the linear relationship between various groups of variables. This analysis technique is a way to present the correlation structure

between two sets of variables in the simplest possible form (Lima et al, 2004). The focus of canonical correlation analysis lies in the correlation between linear combinations of one set of variables with linear combinations of other sets of variables. The first step is to find the linear combinations that have the greatest correlation. Next, we will look for the pair of linear combinations with the greatest correlation value among all the other pairs that are not correlated. The process occurs repeatedly, until the maximum correlation is identified. Linear combined pairs are referred to as canonical variates while the relationship between the pairs is called canonical correlation. This combination will be displayed as follows (Leclere, 2006):

$$W = a_1x_{1+} a_2x_2 +\ldots+ a_px_p$$
$$V= b_1y_{1+} b_2y_2+\ldots + b_qy_q$$

The number of dependent variables or the number of independent variables, whichever is less, will determine the maximum number of canonical functions. Thus, the analysis is based on the derivation of the four canonical functions (Mai and Ness, 1999). There are several studies that have been carried out in the realm of CCA, such as: Mohaghar et al. (2011) that examined the interdependence relationship between supply chain quality and supply chain performance in the automotive industry in Iran; Tutuncu and Kucukusta (2009) that showed a meaningful relationship between job satisfaction and EFQM by utilizing CCA; Macinati (2008) that studied the relationship between TQM and organizational performance; Jang and Ryu (2006) that examined the interdependence relationship in investment and funding decisions in culinary companies (restaurants); Bou-Llusar et al. (2005) that studied the relationship between enablers and outcomes in EFQM; Baloglu et al. (1998) that segmented the tourism market for adult tourists.

3.2. Information gathering tools

According to De Vaus (2002), to answer relevant research questions, appropriate data can be obtained from data collected by other people or other institutions. This data is called a secondary data source. Therefore, the authors use the 2010 GCI report data published by the World Economic Forum (WEF) as a secondary data source.

3.3. Data analysis

Using SAS9 software, the authors have examined the correlation between the two sets of variables "Technological Readiness" and "Business Sophistication" using CCA. To answer the first sub-question, based on table 4, we can see a meaningful positive correlation at the 0.05 significance level between the "Technological Readiness" variable set and the "Business Sophistication" variable set. The variable "Availability of the latest technology" and the variable "Quality of local suppliers" have the strongest correlation, meanwhile the variable "PMA and technology transfer" and the variable "Control of overseas distribution" have the weakest correlation in the table. For example, among the variables "Technological Readiness", the variable "Availability of latest technology" has the strongest correlation and the variable "FDI and technology transfer" has the weakest correlation with "Nature of competitive advantage". In addition, "Technology uptake by enterprise" has the strongest correlation, while "Internet broadband" has little to do with "Cluster development status".

Table 4. Correlation coefficient between "Technological Readiness" and "Business Sophistication"

Business Sophistication / Technological Readiness	Local supplier quantity	Local supplier quality	State of cluster development	Nature of competitive advantage	Value chain breadth	Control of international distribution	Production process sophistication	Extent of marketing	Willingness to delegate authority
Availability of latest technologies	0.639	**0.889**	0.709	0.778	0.808	0.718	0.881	0.887	0.765

Firm-level technology absorption	0.668	0.849	0.755	0.775	0.793	0.741	0.866	0.866	0.786
FDI and technology transfer	0.501	0.630	0.577	0.544	0.595	**0.450**	0.651	0.665	0.606
Internet users	0.451	0.702	0.511	0.641	0.655	0.606	0.774	0.746	0.628
Broadband Internet subscriptions	0.502	0.753	0.555	0.655	0.702	0.611	0.816	0.813	0.604
Internet bandwidth	0.492	0.713	0.495	0.653	0.673	0.575	0.777	0.776	0.567

Table 5. Summary of Canonical Correlation Analysis

N=139	Technological Readiness	Business Sophistication
Variable amount	6	9
Extracted Varians	100%	90.33%
Redundance Index	71.02%	68.80%
Variable : 1	Availability of latest technologies	Local supplier quantity
2	Firm-level technology absorption	Local supplier quality
3	FDI and technology transfer	State of cluster development
4	Internet users	Nature of competitive advantage
5	Broadband Internet subscriptions	Value chain breadth
6	Internet bandwidth	Control of international distribution
7		Production process sophistication
8		Extent of marketing
9		Willingness to delegate authority

Table 5 shows the variation in the data obtained with CCA. The resulting variants for "Technological Readiness" and "Business Sophistication" show that 90.33% of the canonical roots are covered by the internal variation of "Technological Readiness", while 100% of the canonical roots are covered by the internal variation of "Business Sophistication". These statistical results can be considered and support the use of CCA.

Table 6. Statistical testing

Canonical roots	**Chi-square Tests With Successive Roots Removed**					
	Canonical R	Canonical R^2	Chi-sqr	df	P	Lambda Prime
0	**0.951941**	**0.906192**	**401.671**	**54**	**0.00000**	**0.045512**
1	**0.484441**	**0.234683**	**94.0267**	**40**	**0.00000**	**0.485157**
2	0.415852	0.172933	59.2562	28	0.00051	0.633930
3	0.374804	0.140478	34.5731	18	0.01072	0.766480
4	0.270539	0.073191	14.8938	10	0.13604	0.891751
5	0.194489	0.037826	5.0128	4	0.28601	0.962174

The level of ordinary canonical correlation analysis which has meaning for interpretation is 0.05. As shown in table 6, P-value was used for this study; where the first and second canonical variables have statistical meaning. In addition, other statistical tests such as "Lambda Prime" and "" prove the author's research results.

Based on Diagram 1, the author has considered the first canonical variables and ignored the interpretation of the second variables, due to the cross-loading value and weak redundancy index.

To answer the research question, we focus on Tables 5 and 6. The degree of importance of the relationship between "Technological Readiness" and "Business Sophistication" is determined by canonical correlation (Rc) and Eigen value (Rc2). Based on table 6, the first variable Rc is 95.19% and Rc2 is 90.61%. Since Rc cannot directly provide co-variance, a redundancy index is used. The redundancy index for Rc2 is in the form of multiple regression analysis. Table 5 shows that we can estimate a change of more than 68.80% "Business Sophistication" by studying changes to "Technological Readiness". This finding mentions a meaningful relationship between the variable "Technological Readiness" and the variable "Business Sophistication". In addition, it can be concluded that the variable "Technological Readiness" has a positive impact on the variable "Business Sophistication".

The author used canonical cross loading to evaluate the importance of each criterion in meaningful canonical variables in order to answer the second and third sub-questions. In general, a researcher usually faces a choice of interpretations of functions using canonical weights (standard coefficients), canonical loading (structural correlation) or canonical cross loading. Meanwhile, if you can choose, it is suggested that canonical cross loading is superior to canonical loading, which in turn is superior to canonical weight (Hair, 1998).

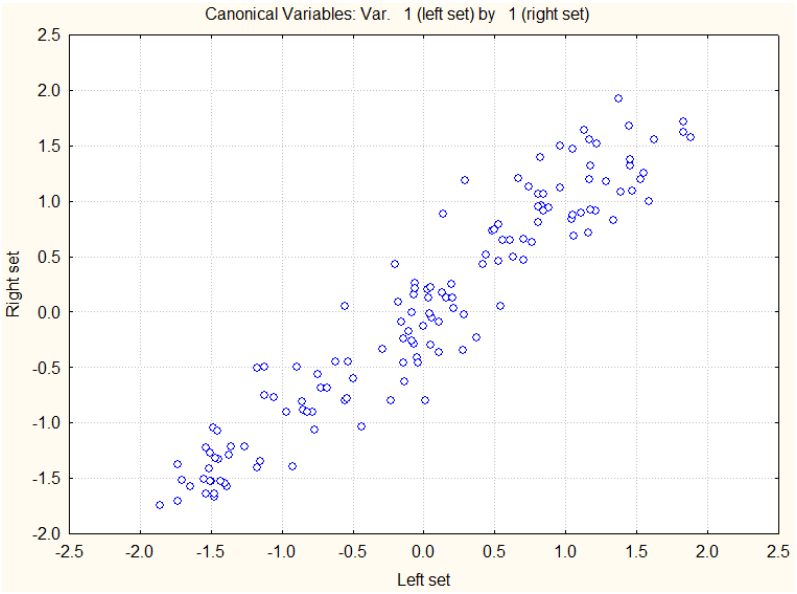

Diagram1. Pairwise correlations between the first canonical variables

Table 7. Canonical loading and canonical cross loading for canonical variables which means "Technological Readiness" & "Business Sophistication"

	Canonical Variable 1		Canonical Variable 2	
	Loading	Cross Loading	Loading	Cross Loading
Technological Readiness				
Availability of latest technologies	0.9631	0.9125	0.0221	0.1244
Firm-level technology absorption	0.9308	0.8820	0.3129	0.2311
FDI and technology transfer	0.6971	0.6401	0.1409	0.1278
Internet users	0.8271	0.7721	-0.1515	-0.0832
Broadband Internet subscriptions	0.8779	0.8177	-0.3573	-0.3903
Internet bandwidth	0.8420	0.7932	-0.3772	0.1688
Extracted variance (%)	74.07		6.85	
Business Sophistication				

Local supplier quantity	0.6877	0.6145	0.2293	0.1328
Local supplier quantity	0.9367	0.8566	0.0332	0.0807
State of cluster development	0.7654	0.7059	0.4202	0.3212
Nature of competitive advantage	0.8373	0.7702	0.1730	0.1123
Value chain breadth	0.8721	0.8111	0.759	0.0923
Control of international distribution	0.7817	0.7236	0.3287	0.1187
Production process sophistication	0.9744	0.9151	0.0603	0.0833
Extent of marketing	0.9749	0.9192	-0.0079	-0.013
Willingness to delegate authority	0.8183	0.7456	0.4478	0.3212
Extracted variance (%)	74.07%		6.85%	
Redundancy index (%)	66.24%		1.5%	

Based on Table 7, all variables in the two sets of variables have high canonical cross loading in creating a canonical variable in their respective variable sets. So, all variables are very effective in creating a meaningful relationship between the variable set "Technological Readiness" and the "Business Sophistication" variable set. Within the set of "Technological Readiness" variables, "Latest technology availability", "Enterprise uptake of technology," and "Broadband Internet subscribers" had the highest impact while "PMA and technology transfer" had the lowest impact in creating the relationship.

Furthermore, among the variables "Business Sophistication", "Scope of marketing", "Production Process Sophistication" and "Quality of local suppliers" had the highest impact, while "Quantity of local suppliers" had the lowest impact in creating the relationship. In addition, based on the high number of canonical cross loading on the two sets of variables, we can conclude that the variable "Technological Readiness" has a positive impact on the variable "Business Sophistication". For the validity of the CCA, the authors used a sensitivity analysis of the independent variables. For such validation, the authors omitted one of the "Technological Readiness" variables each time and made use of the CCA. The results gained describe that there are no changes in the observations related to the coefficient structure of the variables. Hence, the authors believe that the data is valid.

4. Results and discussion

According to the research results, there is a significant relationship between "Technological Readiness" pillar and "Business Sophistication" pillar, and that the variables of "Technological Readiness" pillar have a positive impact on the variables of "Business Sophistication" pillar. Among the variables of the "Technological Readiness" pillar, the variables "Latest technology availability," "Enterprise Uptake," and "Broadband Internet Subscribers", had the greatest impact on creating meaningful relationships. Meanwhile, among the variables of the "Business Sophistication", "Marketing scope", "Production process sophistication" and "Quality of local suppliers" variables had the highest impact on the creation of meaningful relationships.

Some previous studies, as seen in Table 2, have been carried out in the area of Global Competitiveness Index, but they did not focus on relationship between the variables of the pillar of "Technological Readiness" and the variables of the pillar of "Business Sophistication". One of them, that was conducted by Razavi et al (2012) revealed a relationship between both pillars within the stage III (Innovation-based development) which are “Innovation” and “Business Sophistication”. And the other study, that was carried out by Jafarnejad et al (2013) found relationship between “Macroeconomic Environment” and “Technological Readiness”.

5. Conclusion

This study contributes to a better understanding on a nation’s global competitiveness factors, especially the relationship between “Technological Readiness" and "Business Sophistication" pillars. From this study result and other previous studies, we can conclude that there is an interdependency between all the pillars of competitiveness in the GCI, and all of them tend to strengthen each other. This better understanding can stimulate industry players and decision makers to create better efforts and policies to level up their countries’

global competitiveness in comparison to other countries in the region or even in the world. In general, this study can enhance our knowledge and understanding of the relationship between the factors in global competitiveness.

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