Efficacy of the WIPO Global Innovation Index as a Driver of Innovation: Analysis of GII Data for the ten ASEAN Economies

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Abstract: There is a worldwide trend to take account of the WIPO Global Innovation Index (GII) when driving the innovation potential of national economies at a high level as well as at the micro level to encourage local industries. Analysis of the background data shows that such approaches might be misplaced. This study is an in-depth analysis of the underlying GII data of the ten ASEAN economies to determine each economy's patterns, strengths, and weaknesses. The literature guides which pillars and sub-pillars for innovation should be assessed. Analysis should keep at the front of mind that developing nations have significantly differentiated institutional structures, so policy measures from one system cannot be simply taken from one jurisdiction and applied to another. Assessing the components of the seven innovation pillars used by WIPO to develop the annual GIIs shows that a number of the components cannot be improved over the short term. Hence, they will have limited effect on improving the innovation potential of a particular industry. In other words, there is a need to drill down into the data and identify areas for focus to improve innovation potential in both short and medium terms. Simply focussing on the components and pillars that will have the most significant impact on improving the GII is a fool's errand as it may have a limited impact on innovation output. The paper explore the GII rankings at the component level of each of the ten economies: one is developed, six are developing, and three are least developed, according to United Nations criteria. Some components can only be improved at the government level, whilst others can be improved at the industry level. Strategies will then be presented on how industries can improve their innovation potential and hence improve the nation's potential.

Key Words: Global Innovation Index, innovation, WIPO, industrial capacity, European Innovation Scoreboard, PISA, STEM.

1. Introduction

A policy brief by the *Economic Research Institute for ASEAN and East Asia* has analysed development within the ten nations of the ASEAN (Ambashi, 2020: 1). The key messages from the review were:

a.) Foreign direct investment (FDI) and trade will continue to be significant development drivers for the ASEAN members;
b.) To create business opportunities, private enterprise organisations need to enhance their innovation capability;
c.) The policy of human resource development and technology and adoption of each member state should be arranged to match their industrial development stages; finally,
d.) ASEAN Member states 'can use new development strategies based on 4IR [4th Industrial Revolution] and establish an "innovation niche" that is competitive, attractive, and unique to the rest of the world' (p. 1).

Initially, innovation was simply measured in terms of 'inputs (such as expenditures on research and development and the number of research personnel) and outputs (such as patents)' (Organisation for Economic Co-operation and Development, 1997: 1). It argues that, over time, the limitations of such an approach became evident and that there was the need to understand the linkages between the actors in innovation to improve technology performance. This, in turn, led to the development of national innovation systems (p. 1).

The most recognised measure of innovation is the annual Global Innovation Index (GII) which is based on a detailed analysis of seven pillars, namely: institutions, human capital & research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creatives output (Cornell University et al., 2020). The GII is, however, reported as a ranking based on the overall score of the economy. The Global Innovation Index (GII) is based on a detailed analysis of seven pillars: institutions, human capital & research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creatives output. The GII is, however, reported as a ranking based on the overall score of the economy (INSEAD, 2011: 8-9). Each of the input pillars constitutes 20% of the total input score. Each of the output pillars constitutes 50% of the total output score. Then, the input and output scores are added to calculate the total score. Finally, the total scores are ranked.

Every economy appears to have the ambition to move up the GII rankings. Is such an ambition realistic or a fool's errand? What has to be considered is that if all of the economies improved by the same quantum, there would be no change in the rankings. This would apply even though the total score of the inputs plus outputs would have increased across the board. As will be seen, some literature focuses on which pillars, sub-pillars, and individual indicators should be prioritised to improve the GII score and hence the country ranking. Surely the aim should be to improve the innovativeness of the country and the subsequent benefits that it brings.

This study includes an in-depth analysis of the underlying GII data of the ten ASEAN economies to determine the patterns and the strengths and weaknesses of each economy. The literature review will guide which pillars and sub-pillars should be assessed.

2. The Literature

Several recent studies have investigated the efficacy of the GII in measuring innovation. The studies fall into one of two categories: analyses of the efficacy of the GII *per se* or studies investigating innovation in countries based on GII data.

Evidence shows that innovation input positively impacted innovation output, but the impact was more intense at the lower quantiles (Reis et al., 2018: 640). They argue that this seems to contradict, to a certain extent, the argument that the more efforts are directed to innovation, the greater the innovation output. It seemed "more plausible at lower quantiles" (p.640). Analysis of the relationship between Innovation Input and Innovation Output using the GII data from 2013-2020 found that Business sophistication, Human capital and research, and Creative outputs were "the most important and explanatory factors in the formation of the innovation score" (Oturakci, 2021: 7). Finally, there was a statistical difference between income levels of countries and the three significant pillars. The cultural influence on "innovativeness" by investigating the linkages between the "Culture Map" concept and the GII concluded that their study reinforced the outcomes of previous research that "[c]ultural aspects clearly influence the innovativeness of a nation" (Guillén and Deckert, 2021: 8).

A 2017 study analysed the innovation inputs and outputs of the BRICS (Brazil, Russia, India, China, and South Africa using the GII results for 2008-2013 (Franco and de Oliveira, 2017: 82). They found that for BRICS as a whole, the inputs can explain the output of knowledge. However, the outcome changed when the analysis was undertaken country by country. They argue that '[P]erhaps this result shows the need for the BRICS countries to cooperate to stimulate the development of the innovation process' (p. 85). They considered that the GII could be improved by focusing on the Human Capital, Market Sophistication and Business sophistication pillars. The question: "which innovation inputs are more strongly related to innovative outputs?" was the basis of a study by Duarte and Carvalho (2020: 2). Overall, Knowledge Absorption was key in determining innovation readiness in the Eurozone countries. As a result, they considered that improving the knowledge absorption capacity of domestic firms is likely to enhance the innovation outputs of Portugal.

Pençe et al. (2019) found that the 27 GII indicators identified by Şimşit et al. (2014) were "good enough for estimating the ranking scores of countries… Consequently, if a country wants to improve its ranking on the GII list, it needs to improve only these selected features" (pp. 19470007-11 – 19470007-12). Following research using the GII data for 2013, Sohn et al. (2016) opined that the results showed that infrastructure or business sophistication is more important than human capital and research. Analysis of GII data from Kazakhstan found that dependence between components of the indices is subjective as the "data array over the countries increases every year", and the total rating of a country and the main sections of the indices of a country depends on the rating positions of other countries and could give incorrect results (Stavbunik and Pelucha, 2019: 13-14). It has also been argued that innovation policies or their economic impacts have only been analysed in a few in-depth studies (Dobrzanski and Bobowski, 2020: 2)

Any analysis should keep at the in mind an earlier article by Gu (1999) in which he argues that as developing nations have significantly differentiated institutional structures, policy measures from one system cannot be simply moved from one jurisdiction to another. Therefore, detailed policy measures may be better made only based on intimate analysis of local situations in technology, institution, human capital, and other aspects. Moreover, an initiated policy must be open to timely adjustment (p. 61).

Based on the abovementioned findings as to which pillars and sub-pillars should be assessed, this paper then investigates the potential impediments to innovation in the ten ASEAN economies.

3. Findings

3.1 Trends in the GII of the ASEAN Economies

The Organisation for Economic Cooperation and Development (OECD) reported in 2013 that a coherent policy focus on innovation was lacking in most ASEAN countries. However, several have adopted an R&D-centric approach to developing innovation (OECD, 2013: 111).

Singapore and Malaysia were the exceptions, as innovation is included in their national development strategies (p. 111). It was considered that "[i]nnovation policy is not likely to compensate for seriously flawed framework conditions" (113). In many parts of the region, regulatory and legal systems created barriers to innovation (p. 114). Whilst the IP regulatory regimes generally met international practices, the institutional and legal capacity in the lesser developed countries was insufficient to manage and provide legal support in IP matters (p. 116).

The OECD findings are not really surprising considering that ASEAN consists of one *High-Income* country (Singapore), two *Upper Middle Income* (Malaysia and Thailand) and six *Lower Middle Income* (Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, Vietnam) (World Bank, 2022). Despite their *Lower Middle Income,* the United Nations Conference on Trade and Development (UCTAD) includes Cambodia, Lao PDR and Myanmar in their list of *least-developed countries* (UNCTAD, 2022). In addition, Myanmar is in a state of economic turmoil following a coup d'état that overthrew the democratically elected government in 2021. It is too soon for the impact of the coup to be reflected in the data being considered for this study.

The Global Innovation rankings of the ASEAN members for 2011 – 2022 are provided in Table 1. Singapore is by far the best-performing ASEAN member. The three lowest performing countries are the least developed: Cambodia, Lao PDR and Myanmar. The Philippines has shown the most significant improvement over the ten years, with Thailand and Vietnam significantly improving. Malaysia has been reasonably consistent, whilst Indonesia has improved but is still relatively poorly placed.

Table 1: Global Innovation Indices of ASEAN Members 2011-2022

Country	Global Innovation Index											
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Brunei Darussalam	-	53	74	88	-	-	71	67	71	71	82	92
Cambodia	111	129	110	106	91	95	101	98	98	110	109	97
Indonesia	99	100	85	87	97	88	87	85	85	85	87	75
Lao PDR	-	-	-	-	-	-	-	-	-	113	117	112
Malaysia	31	32	32	33	32	35	37	35	35	33	36	36
Myanmar	-	-	-	-	-	-	-	-	-	129	127	116
Philippines	91	95	90	100	83	74	73	73	54	50	51	59
Singapore	3	3	8	7	7	6	7	5	8	8	8	7
Thailand	48	57	57	48	55	52	51	44	43	44	43	43
Vietnam	51	76	76	71	52	59	47	45	42	42	44	48

Source: (INSEAD, 2011; WIPO and INSEAD, 2012; Cornell University et al., 2013; Cornell University et al., 2014; Cornell University et al., 2015; Cornell University et al., 2016; Cornell University et al., 2017; Cornell University et al., 2018; Cornell University et al., 2019; Cornell University et al., 2020; WIPO, 2021; WIPO, 2022)

We next drill down into the 2022 data to analyse the innovation scores on each of the seven pillars (Table 2). The *input GII score* is the sum of 20% of each of the scores of input pillars. The *output GII score* is the sum of 50% of each of the scores of the two output pillars. The overall GII is the mean of the output and input scores. *Innovation Efficiency* is simply the *output GII* divided by the *input GII*.

Table 2: Global Innovation Scores of ASEAN Members Overall and by Pillars 2022

Country	Overall GII	Output GII	Input GII	Innovation Efficiency	Institutions	Human Capital & Research	Infrastructure	Market Sophistication	Business sophistication	Knowledge and Technology Outputs	Creative Outputs
Brunei Darussalam	22.2	3.1	41.2	0.08	74.5	35.2	45.5	23.5	27.4	4.2	2.0
Cambodia	20.5	9.6	31.4	0.31	50.4	20.0	30.9	38.2	17.6	11.9	7.3
Indonesia	27.9	18.8	36.9	0.51	55.1	22.4	43.4	41.7	22.1	19.0	18.6
Lao PDR	17.4	6.1	28.8	0.21	46.7	16.4	26.1	34.8	20.0	7.2	5.0
Malaysia	38.7	29.4	48.0	0.61	68.8	41.0	48.6	45.3	36.3	31.5	27.4
Myanmar	16.4	9.3	23.4	0.40	38.1	18.4	21.4	25.1	14.1	12.0	6.6
Philippines	30.7	25.7	35.7	0.72	48.7	25.0	38.7	29.2	36.9	30.8	20.5
Singapore	57.3	43.9	70.6	0.62	95.9	61.5	61.4	68.4	65.7	49.3	38.5
Thailand	34.9	27.6	42.1	0.66	52.5	29.8	47.7	45.3	35.3	30.0	25.2
Vietnam	34.2	28.4	40.1	0.71	60.6	27.2	42.5	38.4	31.6	26.0	30.8
Contribution to Inputs					20%	20%	20%	20%	20%		
Contribution to Outputs										50%	50%

Source: (WIPO, 2022)

To better understand the data, the methodology utilised by the European Union to prepare the European Innovation Scoreboard (European Commission Directorate-General for Research and Innovation et al., 2022) was followed. The mean of the GII 2022 scores is 31.53; the data is provided in Table 3. The process is based on the mean value and uses four categories:

a) Emerging Innovators - < less than 70% of the mean
b) Moderate Innovators – between 70% and 100% of the mean
c) Stronger Innovators – between 100% and 125% of the mean
d) Innovation Leaders – greater than 125% of the mean

Table 3: Analysis of GIIs using the European Innovation Scoreboard Approach

Country	GII Rank	Overall GII Score	Performance Score	Category
Brunei Darussalam	92	22.2	70	Moderate Innovator
Cambodia	97	20.5	65	Emerging Innovator
Indonesia	75	27.9	88	Moderate Innovator
Lao PDR	112	17.4	55	Emerging Innovator
Malaysia	36	38.7	123	Strong Innovator
Myanmar	116	16.4	52	Emerging Innovator
Philippines	59	30.7	97	Moderate Innovator
Singapore	7	57.3	182	Innovation Leader
Thailand	43	34.9	111	Strong Innovator
Vietnam	48	34.2	108	Strong Innovator

As expected, the results show that Singapore is an Innovation Leader and is well ahead of all other ASEAN members in terms of innovation. Whilst Malaysia is only seven steps ahead of Thailand on the GII ranking, its performance is 10 points higher than that of Thailand. On the other hand, Thailand is 43 on the GII ranking, which is five steps ahead of Vietnam, but all have similar performance scores. Space precludes further discussion of this approach, but it is considered that it should be investigated further.

3.2 Drilling Down into the Key GII Components

Table 3 provides the 2022 rankings on the components identified by (Pençe et al., 2019) as the areas a country needs to improve to improve its GII ranking. Some interventions will bring about significant improvement but will only occur gradually over a significant timeframe. Others will possibly bring about improvements over a shorter timeframe. Other components may impact the GII but will have little impact on improving a country's innovation potential. The examples are used for illustration as a detailed analysis of all ten member states is impossible to report in this article.

Table 3: Rankings of ASEAN Members on Key GII Components 2022

Country	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
Human Capital and Research										
2.1.4 PISA scales in reading, maths and science	53	n/a	72	n/a	48	n/a	77	2	61	16
2.2.2 Graduates in science and engineering	4	47	73	49	3	12	52	9	27	54
2.3.1 Researchers	n/a	102	75	n/a	38	101	84	5	41	60
2.3.2 Gross expenditure on R&D (GERD)	81	102	80	n/a	40	95	75	19	36	59
Infrastructure										
3.1.3 Government's online services	80	112	72	130	24	127	60	5	42	78
3.1.4 Online e-participation	93	111	57	129	29	128	57	6	51	70
Business Sophistication										
5.1.1 Knowledge-intensive employment	44	110	123	95	52	119	80	2	90	106
5.1.3 GERD performed by business	n/a	84	82	n/a	41	n/a	68	21	30	45
5.1.4 GERD financed by business	100	66	79	n/a	45	100	47	20	1	10
5.1.5 Females employed with advanced degrees	63	105	88	97	52	86	58	6	71	85
5.2.1 University/industry research collaboration	40	85	13	63	36	126	64	7	38	26
5.2.3 GERD financed from abroad	92	52	94	n/a	43	79	89	37	80	59
5.3.2 High-tech imports	116	126	32	123	4	77	3	6	13	1
5.3.3 ICT services imports	27	99	39	128	37	87	50	13	119	130
5.3.4 Foreign direct investment net inflows	27	9	76	17	72	58	66	5	105	15
Knowledge and Technology Outputs										
6.1.4 Scientific and technical publications	68	114	128	115	52	126	122	32	79	90

Country	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam
6.2.3 Total computer software spending	n/a	109	24	n/a	34	n/a	61	50	54	45
6.2.5 High-tech manufacturing	n/a	n/a	43	100	18	67	28	1	22	44
6.3.2 Production and export complexity	n/a	86	60	90	24	108	28	5	23	56
6.3.3 High-tech exports	103	68	46	45	1	69	2	1	8	3
6.3.4 ICT services exports	129	109	92	101	75	100	14	47	126	120
Creative Outputs										
7.2.1 Cultural and creative services exports	106	n/a	96	n/a	63	64	83	1	103	94
7.3.1 Generic top-level domains (gTLDs)	47	92	89	78	48	127	90	23	51	71
7.3.2 Country-code top-level domains (ccTLDs)	83	121	93	66	59	127	101	37	100	70
7.3.3 GitHub pushes received (replacing Wikipedia monthly edits)	65	96	72	114	62	122	85	1	80	63
7.3.4 Mobile app creation	102	56	60	n/a	66	100	62	4	59	8

Source: (WIPO, 2022)

3.2.1 Human Capital & Research

The biggest impediment to innovation appears to be the education system as measured by the PISA score (OECD, 2018; Adams and Wu, 2002).

For example, the ranking of Thailand is 61 (GPS, 2019). Delving further into the PISA data for Thailand showed that:

a.) Student performance in reading was some of the lowest in the 76 countries and economies in 2018, with girls performing statistically better than boys by 39 points;
b.) Student performance in mathematics was significantly lower than the OECD average, with girls performing statistically better than boys by 30 points; and
c.) There were similar results in science, with girls performing significantly better than girls by 20 points.

Clearly, there are significant deficiencies in the Thai education system, and this is potentially the most significant impediment to innovation in Thailand. Nevertheless, Thailand has obviously been effective in attracting students to STEM (science, technology, engineering and mathematics) courses.

3.2.2 Infrastructure

The components identified as key for infrastructure improvements were key initiatives during the COVID-19 pandemic (Smith and Perry, 2022: 507).

3.2.3 Business Sophistication

Business sophistication has the most complex set of components. Singapore appears to have been able to address all of the components. For most countries, however, the focus should be on the components of most relevance. For instance, Thailand may not require foreign direct investment (FDI) inflows but Thailand and Vietnam should concentrate on improving knowledge-intensive employment opportunities.

3.2.4 Knowledge and Technology Outputs

There are issues with abstracting services used to assess scientific and technical publications. It only includes articles included in the Clarivate Web of Science database (WIPO, 2022: 249). In addition, in most of the

countries, English is not the language of education. Researchers often have difficulty writing in English. Therefore they publish in journals in the national language, which is not indexed (see, for instance, Smith, 2019). Again, the government should select areas where it seeks to excel. For instance, the Philippines has developed a niche in ICT exports. Thailand and Vietnam are able to focus on other areas.

3.2.5 Creative Outputs

It is considered that there are also issues in measuring creative outputs. There is little action that countries can take concerning topic-level domains and country-code top-level domains, as many types are excluded (WIPO, 2022: 253). "GitHub commit pushes received refers to the number of batched changes received by publicly-available projects on GitHub within a specific economy" (p. 254) and replaces Wikipedia edits.

4. Discussion & Recommendations

The preliminary analysis above demonstrates that countries need to examine the data to ascertain where improvements need to be made to improve their innovation potential. They should focus not just on improving their GII ranking but on areas of improvement that are effective. There is no sense in trying to pursue all areas. Most, but not all, the ASEAN economies must focus on fundamental changes to their primary and secondary school systems. There must be a greater emphasis on creative thinking rather than rote learning. There is a similar role to be played within the university system.

Countries, as well as private industry, should promote and fund the study of STEM (science, technology, engineering and mathematics) courses. Women should be encouraged to undertake postgraduate studies and then be employed in industry and government. Universities must provide resources for their staff to become fluent in English language writing and to be able to publish in English. This comment is not meant to denigrate the use of the mother tongue but rather to give their research outputs a greater audience and, hence, a more significant impact. This also enhances their reputation through greater communicationn.

The GII, per se, is not an efficacious driver of innovation. It drives innovation if countries and industries drill down into the data. That is where the most benefit can be achieved. Adopting the European Innovation Scoreboard Approach to present the data should also be considered as a more relevant course. This would, hopefully, encourage countries to dig deeper into the data and explore its finer nuances rather than just trying to move up the GII rankings.

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