Factors Impacting the Effectiveness of National Innovation: Lessons Learned From the Five Most Innovative Countries in the World

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Received: June 5, 2026 Accepted: June 30, 2026 Online Published: July 5, 2026

doi:10.5430/ijba.v17n2p20 URL: https://doi.org/10.5430/ijba.v17n2p20

Abstract

Although several studies have examined issues related to national innovation systems (NISs), few have investigated the factors that make some countries more innovative than others. Per the 17th edition of the 2024 Global Innovation Index (GII), the five most innovative countries in the world were Switzerland, Sweden, the United States of America (U.S.), Singapore, and the United Kingdom (U.K.). This study aims to investigate the factors that enabled the above countries to be the most innovative and to identify lessons that can be learned. This study acknowledges that measuring innovation outputs and their outcomes is not easy because the innovation process is multi-faceted; thus, the GII captures the multi-dimensional facets of innovation by assessing the climate, institutions, and infrastructure for innovation and evaluating associated outcomes. This study indicates that although the five countries had the highest overall GII scores, the scores of their seven GII pillars differed. While some performed well in input innovation pillars (e.g., Singapore), others performed well in innovation output pillars (e.g., Switzerland). In addition, their GII rankings, except for Switzerland, fluctuated over the past eleven years (2014-2024), which may indicate that they have strengths and weaknesses. Overall, those countries were able to put in place favorable conditions for most of the seven GII pillars and put innovation at the center of their national agenda. This study also discusses its implications, limitations, and future research directions.

Keywords: innovation, national innovation systems, global innovation index, GII, NIS, Switzerland, Sweden, the U.S., Singapore, the U.K.

1. Introduction

Innovation has become a popular topic as an indicator of national competitiveness. It is critical for economic progress and competitiveness (OECD, 2002; Vlasova & Saprykina, 2024). Innovation creates opportunities and is vital to a nation's economic growth. Innovation is a factor that impacts a country's technological, financial, and social development (Edquist et al., 2018; Huarng & Yu, 2022; Raghupathi & Raghupathi, 2017). More innovative countries have a competitive advantage in today's rapidly changing global economy (Chung, 2002). Consequently, innovation is believed to be a fundamental driver for economic growth.

Measuring innovation activities and performance has received increasing attention from researchers and policymakers (Alqararah, 2023; Oh & Yi, 2022). Innovation indices help measure innovation activities and success at a national level. Some international institutions have developed competitive indices to evaluate national innovative capacity (Chaminade, Lundvall, & Hanee, 2018; Nasir & Zhang, 2024). Some of the known international institutions that have developed competitive indices are the Global Innovation Index (GII), the Innovation Union Scoreboard, the World Economic Forum, the European Innovation Scoreboard, and the Institute for Management Development (Nasir & Zhang, 2024; Oturakci, 2019). Although the indices mentioned above are widely used tools for measuring nations' innovation capabilities and success and play an important role in shaping and guiding innovation policies, the GII is the most popular (Alqararah, 2023; Edquist et al., 2018).

This study adopts the GII as a framework. The GII was built mainly based on the assumptions of the National Innovation System (NIS), which assumes the performance of a national innovation mainly depends on the effectiveness of the interactions and collaborations among the major actors involved in the generation, diffusion, and adoption of innovation (Freeman, 1987; Majumdar, 2024). The GII captures the innovative ecosystem performance of most countries (the World Intellectual Property Organization, WIPO, 2024), measures different aspects of the innovation ecosystem by country (Yu, Huarng, & Huang, 2021), ranks countries according to their innovation abilities and success (Dutta et al., 2023), measures a country's innovation competitiveness (Huarng & Yu, 2022), reveals both strengths and weaknesses in the national innovation performance (Dutta et al., 2024), includes the major components of national innovation system (NIS) approach (Crespo & Crespo, 2016), and is a reliable source for academic studies (Brás, 2023). As a result, it has been a leading reference for researchers, policymakers, and business executives (Alqararah, 2023; Fernandes, Rodrigues, & Ferreira, 2022; Huarng & Yu, 2022).

In this study, we used the GII conceptual framework. It includes the following two sub-indices: the Innovation Input Sub-Index (IISI) and the Innovation Output Sub-Index (IOSI) (Alqararah, 2023). The overall GII ranking is based on the above two equally important sub-indices in ranking countries (WIPO, 2024). The IISI includes five input pillars (human capital and research, institutions, infrastructure, business sophistication, and market sophistication) that capture components of the economy that facilitate innovative activities. The IOSI includes two pillars (creative output and knowledge and technology output) that result from innovative activities within each country. Each of the seven pillars comprises 21 sub-pillars, including 78 specific indicators (WIPO, 2024). The 78 indicators assess the political environment, education, infrastructure, and knowledge creation (Nasir & Zhang, 2024).

Prior studies have used the GII datasets for different research agendas: to investigate the correlation between IISI and IOSI (Hamid & Berrado, 2018; Jankowska et al., 2017; Nasir & Zhang, 2024; Oturakci, 2021; Yu, Huarng, & Huang, 2021), to analyze the whole relationships of the GII (Huarng & Yu, 2022), to examine the correlation among factors impacting the performance of national innovation (Bate, Wachira, & Danka, 2023; Sohn & Kim, 2016), to compare IISI and IOSI of high-income and low-income counties (Crespo & Crespo, 2016), and to assess the robustness of composite indicators of GII (Alqararah, 2023). To our knowledge, no study has analyzed the IISI and IOSI of the five most innovative countries in the world as per the 2024 GII rankings (Switzerland, Sweden, the U.S., Singapore, and the U.K.) and we intended to investigate the factors that made those five countries stand out. Specifically, this study has two main objectives: (1) to investigate and discuss the IISI and IOSI of the five most innovative countries and (2) to identify lessons that can be learned.

This study uses the multiple-case (embedded) design (Yin, 2017) because it is a type of case study research that involves choosing and analyzing two or more cases that share some common characteristics but differ in some respects.

2. Literature Review

2.1 Concept of Innovation

Innovation is a hot topic as it is a relevant and critical national issue. Joseph Schumpeter introduced the concept of innovation in 1911 (Fagerberg & Verspagen, 2009), and then it was popularized by Giovanni Dosi, Chris Freeman, Nathan Rosenberg, and Sidney Winter. Since then, interest in innovation in academic settings has increased (Chung, 2020; Oh & Yi, 2022). Innovation does not happen in a vacuum. It requires the interactions of many actors. Developing, testing, and adopting innovation cannot be conducted by one actor working in isolation. The support (e.g., technical, financial, and political support) of many actors (e.g., research institutions, government, private equity firms, startups & enterprises, market facilitators & intermediaries, professionals, and industries) is required to successfully progress in the innovation process (Giusti, Alberti, & Belfanti, 2022; Ruoslahti, 2020). The effectiveness of an innovation system mainly depends on the effectiveness of the interactions between the major actors involved in generating and diffusing knowledge (OECD, 2002; Ruoslahti, 2020). Hence, the innovation process is complex as it involves many dynamic arrangements and links (Laursen & Andersen, 2023; Metcalfe & Ramlogan, 2008; Oh & Yi, 2022).

In the past, innovation focused on research and development (RD)-based product innovation, which was mainly produced in manufacturing industries (Chaminade et al., 2018; Vlasova & Saprykina, 2024). Such innovation was implemented in RD-concentrated companies, and thus, it was conceptualized as internal, closed, and localized (Chung, 2020). However, gradually, the concept of innovation has broadened to become more general and horizontal

(Oh & Yi, 2022). It is no longer restricted to R&D workrooms and published scientific papers. According to OECD and Eurostat (2018: 20), it refers to a new or improved product or process that differs from the prior products or processes and that has been made available to users. Investment in innovation-related activities has increased constantly at the organizational, national, and global levels (Chaminade et al., 2018; Giusti et al., 2022; Lundvall, 2007; Marxt & Brunner, 2013). Thus, this study uses a general definition of innovation that encompasses the generation of new ideas and the improvement of existing ones.

2.2 The Concept of the Global Innovation Index (GII)

The GII, as an index, "ranks countries by their success in innovation" (WIPO, 2024). In 2007, Professor Soumitra Dutta launched the GII, and the first edition was published in collaboration with INSEAD and World Business (Suseno et al., 2020). Since 2012, WIPO has been publishing the GII in partnership with Professor Dutta, Cornell University, Professor Bruno Lanvin, INSEAD, Portulans Institute, the GII Advisory Board, and several corporate and academic network partners (Brás, 2023). It has also partnered with Academic Networks from 13 countries (WIPO, 2024).

The GII intends to capture the multi-dimensional aspects of innovation (Sohn et al., 2016; Reis et al., 2018; Yu et al., 2022) and helps to track the innovation capabilities (potential) using input and output criteria (Nyssen, Guillén, & Deckert, 2021). The GII has served as the basis for assessing national innovation competence (Pençe et al., 2019). As a result, it has become a leading resource for policymakers, academics, and executives interested in national innovative-related issues (Lager & Bruch, 2021; Nasir & Zhang, 2024).

One of the main challenges in measuring national innovation activities and performance is finding reliable and valid metrics. There is a scarcity of direct formal measures that quantify innovation outputs (Reis et al., 2018; Yu et al., 2022), as many countries do not keep statistics on the number of innovative activities and outputs. However, significant resources have been invested, and attempts have been made to improve the quality of GII data (Yu et al., 2022). Thus, the GII can be regarded as a systematic attempt that has been refined over the past 17 years (Dutta et al., 2024).

The GII has been vital by offering important datasets and countries' innovation rankings to researchers and governments. For example, it has helped researchers conduct innovation-related research and countries to systematically analyze, measure, and benchmark their annual innovative activities and performance and develop evidence-based innovation policies (Carpita & Ciavolino, 2017; Dutta et al., 2023; Pençe et al., 2019).

2.3 The GII Conceptual Framework

The main goal of the GII is to identify the conditions that impact innovation and capture the multi-dimensional facets of innovation. For that reason, its conceptual framework (Figure 1) is intended to measure the national innovation activities and performance using seven pillars/factors, which are grouped into two major indices: IISI and IOSI. The seven enabler pillars define facets of the environment favorable to innovation within a country. The IISI includes five input pillars (institutions, infrastructure, human capital and research, business sophistication, & market sophistication) that capture components of the economy that facilitate innovative activities (Majumdar, 2024; WIPO, 2023). The innovation inputs refer to the efforts that countries put into developing a human capital base, science, and the related innovation environment (Nyssen et al., 2023). They capture components of the national economy that promote innovative activities (Lager & Bruch, 2021). The assumption is that the current innovation inputs prepare the foundation for future innovation outputs. The IOSI includes two innovation output pillars (creative output & knowledge and technology output) that are the result of innovative activities in a country (Nasir & Zhang, 2024).

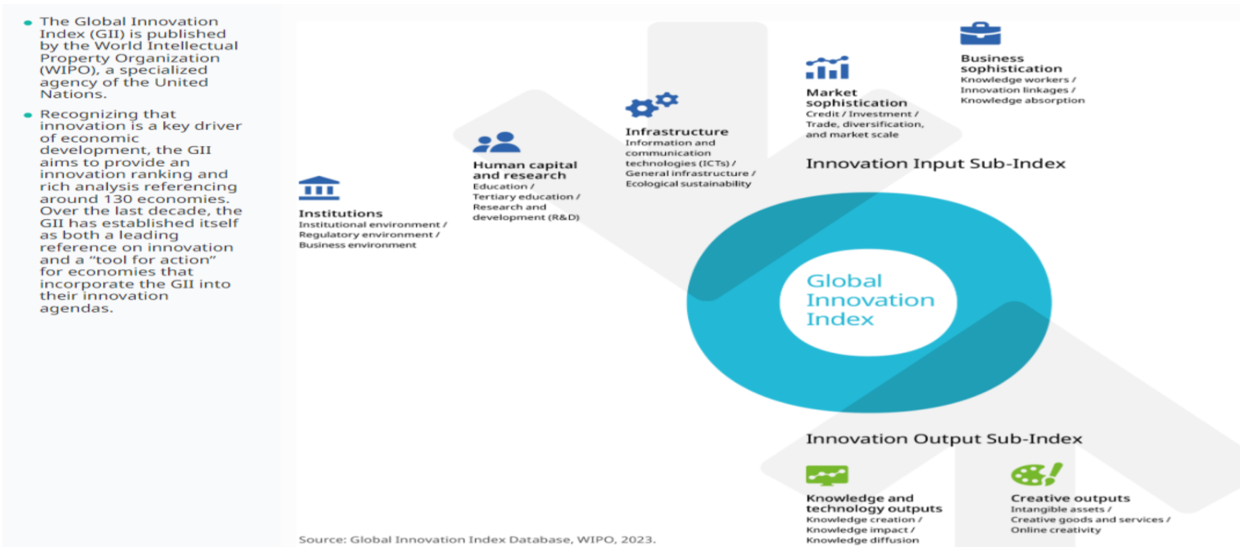


Figure 1. Framework of the GII 2024

The GII uses several pillars, which are grouped under two broad categories, namely IISI and IOSI (Figure 1), and are briefly discussed below:

1). Institutions

It measures the institutional capacity of a country to effectively implement policies that invite and encourage innovative actors. This factor includes three specific factors: The political environment, the business environment, and the regulatory environment (WIPO, 2024). *The political environment* measures the extent to which there is political stability and peace in the country and whether the political system makes business-friendly decisions that promote businesses. *The regulatory environment* measures the degree to which the government formulates and implements policies encouraging the private sector to flourish by keeping administrative burdens to a minimum. *The business environment* measures the extent to which it enables the private sector to experiment with new business ideas and establish its own business by giving protection and incentives. Prior studies reported that institutions had a significant impact on the performance of a national innovation (Bate et al., 2023; Hamidi & Berrado, 2018).

2). Human capital and research

It measures the quality of the pre- and post-secondary education and research activities in a country, which impacts a nation's innovation capacity. This factor comprises three specific factors: pre-secondary education, post-secondary education, and RD (WIPO, 2023). While the education factor measures the government's expenditure on education and achievements at the pre- and post-secondary levels, the RD factor measures a country's quality and quantity of activities related to RD (WIPO, 2024). Research indicated that human capital and research profoundly affected national innovation performance (Oturakci, 2021; Suseno et al., 2020).

3). Infrastructure

It measures the availability of communication, energy, and transport infrastructures that promote idea production and exchange, help increase productivity, lower transaction costs, and enhance market access. Specifically, it includes the following three factors: Information and communication technologies (ICTs), ecological sustainability, and general infrastructure (Dutta et al., 2024; WIPO, 2023). While the ICTs measure the magnitude of ICT access and use in a country, the general infrastructure measures the physical, technological, and social systems that impact innovation activities. Furthermore, ecological sustainability measures the ability of ecosystems to remain productive while maintaining natural regenerative capacity (WIPO, 2024). Previous studies reported that infrastructure significantly impacted national innovation performance (Bate et al., 2023; Elahi, 2026; Freeman, 2004).

4). Market sophistication

It measures credit accessibility and an environment that promotes investment, which are vital for businesses to flourish and innovation to occur. It includes the following three specific factors: Finance for startups and scaleups, conduciveness to investment, and trade and market scale (WIPO, 2023). Finance for scaleups and startups measures the availability of credits for business; conduciveness to investment measures the extent to which there is a favorable investment landscape; and trade and market scale measures a tax imposed by the government and domestic market scale as measured by GDP (WIPO, 2024). Research indicates that market sophistication profoundly affects national innovation performance (Proksch, 2017; Vukoszavlyev, 2019).

5). Business sophistication

It measures the level of business sophistication and the degree to which it is conducive to business innovation activities. It includes three specific factors: Knowledge workers, knowledge absorption, and innovation linkages (WIPO, 2024). Knowledge workers measure the extent to which the country has adequate workers who can collect, analyze, utilize, and share information. Innovation linkages measure the extent to which the government has strong innovation linkages of public/private/academic partnerships. Knowledge absorption measures the extent to which the country can acquire, understand, and use new knowledge (WIPO, 2023). Prior studies reported that business sophistication had a significant impact on the performance of national innovation (Bate et al., 2023; Yu et al., 2021).

6). Knowledge and technology outputs

It measures the products of innovation. It includes the following specific factors: knowledge impact, knowledge creation, and knowledge diffusion. While knowledge creation includes activities such as patent applications filed by the country's residents and scientific and technical articles, knowledge impact includes statistical data related to the impact of national innovation activities (e.g., labor productivity and high-tech manufacturing). Moreover, knowledge diffusion includes statistics related to sectors that are key to innovation and those with high-tech content (WIPO, 2024). Research indicated that knowledge and technology outputs profoundly affected national innovation performance (Proksch, Haberstroh, & Pinkwart, 2017; Teslenko et al., 2021).

7). Creative outputs

It measures creative outputs, which occurred mainly because of the innovation inputs and includes the following three specific factors: creative goods and services, intangible assets, and online creativity (WIPO, 2023). Intangible assets include factors such as the number of trademark applications by the country's residents, intangible asset intensity, and industrial designs included in applications. Creative goods and services include proxies to get at a country's creativity and creative outputs. Online creativity also includes mobile app creation and generic top-level domains (WIPO, 2024). Prior studies indicated that creative outputs significantly impacted national innovation performance (Oturakci, 2021; Proksch, 2017).

3. Data and Research Method

This section discusses the GII data, variables, measurements, reliability, and research method utilized in this study.

3.1 The GII Data

The GII data used in this study were collected mainly from the 2024 GII files on the WIPO website. The dataset had 78 indicators collected from 133 countries, representing 94.7 percent of the world's population (WIPO, 2024). They are derived from socio-economic data such as government expenditures, global R&D companies' expenditures, tertiary education enrollment, and ICT usage (Oh & Yi, 2022) and were also obtained from other sources (e.g., the World Bank, the International Monetary Fund, the United Nations, International Telecommunication, and the World Economic Forum (WIPO, 2024). The definition of innovation has broadened and measured factors that impact innovation activities and performance, such as each country's political environment, infrastructure, education, and knowledge creation (Nasir & Zhang, 2024). Additional data and information from each of those five countries were also added. The GII is a rich and valuable database of detailed metrics and a convenient information source for conducting research and refining innovation policies (Huarng & Yu, 2022; WIPO, 2024).

3.2 The GII Variables

Since measuring innovation outputs and their effect is challenging, the GII assesses the climate and infrastructure for innovation and evaluates related effects (WIPO, 2024). The 2024 GII rankings use two sets of pillars: IISI and IOSI (Figure 1). Under the seven pillars of the IISI and IOSI, there are 21 sub-pillars, and under the 21 sub-pillars, 78 indicators are chosen for their relevance to specific innovation sub-pillars (Dutta et al., 2024). The GII 2024 model consists of 78 indicators, of which 63 are related to quantitative/objective/complex data, 10 are related to composite indicators/index data, and five are related to qualitative/subjective data (WIPO, 2024). The pillars, sub-pillars, and indicators were selected based on expert opinion and statistical analysis (Brás, 2023; Yu et al., 2022).

3.3 The GII Measurements

The overall GII ranking is based on two sub-indices, namely the IISI and the IOSI. They are equally significant in ranking countries. Although the IISI and the IOSI include five and two pillars, respectively, they have equal weight (Dutta et al., 2024). While each of the five input pillars has a weight of 0.10, each of the two output pillars has a weight of 0.25 (WIPO, 2024). The GII presents three scores: IISI, IOSI, and the overall GII score. Sub-pillars are calculated based on the weighted average of their indicators and are normalized to have the form of scores between 0 and 100. The higher the scores, the higher the innovation performance. The aggregation methods the GII utilizes are arithmetic and weighted average (Dutta et al., 2024). In constructing every composite indicator (CI), assigning weights is an essential element of the process (Alqararah, 2023). Due to the innovation's multi-dimensional nature, there are many layers in its measurement (Alqararah, 2023; Edquist et al., 2018), and the GII dataset is appropriate for measuring the IISI and IOSI (Lager & Bruch, 2021). Therefore, we found the GII data relevant for the current study.

3.4 GII Data's Reliability and Validity

Many studies indicated that the GII data are reliable for the following reasons: First, the pillars have higher Cronbach's alpha values (Dutta et al., 2024). Second, it is audited by the European Commission's Competence Centre (WIPO, 2023). Third, it meets the global quality standards for statistical soundness (Brás, 2023). Fourth, it is based on a literature review and expert opinion (Yu et al., 2022). Fifth, it involves renowned international organizations (e.g., WIPO, INSEAD, Cornell University, Portulans Institute, and the GII Advisory Board). As a result, the GII data have become of exceptional value for research purposes (Brás, 2023).

4. Methodology

For this study, the multiple-case (embedded) design is considered most suitable (Yin, 2017). This is because it is a type of case study design that involves choosing and analyzing two or more cases with some common characteristics but differing in some respects (Creswell & Creswell, 2017). The main goal of a multi-case study is to compare the cases and identify the similarities and differences among them, as well as the patterns that emerge from the cross-case analysis (Creswell & Creswell, 2017). Comparing and contrasting different cases can help researchers better understand the situation. This study also involves extracting, organizing, tabulating, depicting, and describing GII data (related to the seven pillars impacting the performance of the national innovation) of the five countries meaningfully and concisely. Such a process can help us compare the innovation activities and performance of the five most innovative countries and uncover their unique strengths and weaknesses, which in turn facilitate the identification of the lessons that can be learned from their experiences.

5. Results/Findings

This section presents the findings of the study.

Table 1 provides background information (population, region, GDP, PPP$, and GDP per capita) on the GII 2024's five most innovative countries (Switzerland, Sweden, the U.S., Singapore, and the U.K.).

Table 1. Background information of the five most innovative countries- GII 2024

	Country	***2024 GII rank***	***Background information***			
			Region	***Population (m)***	***GDP, PPP$ (bn)***	***GDP per capita, PPP$***
1	Switzerland	1	EUR	8.9	787.3	89,537
2	Sweden	2	EUR	10.6	716	66,209
3	The U.S.	3	NAC	343	26,949.6	80,412
4	Singapore	5	SEAO	5.8	753.3	133,108
5	The U.K.	4	EUR	68.7	3,871.8	56,836

Source: WIPO, 2024

Table 2 presents the scores of the seven GII pillars of the five most innovative countries. The five most innovative countries had different rankings in the seven GII pillars. For example, Singapore ranked top in institutions, Sweden ranked first in infrastructure and business sophistication, the U.S. ranked top in market sophistication, and

Switzerland ranked top in knowledge and technology outputs and creative outputs. However, the cumulative scores of their input and output innovation made them the top five innovative countries.

Table 2. GII 2024- The five most innovative countries and their rank in the seven innovation pillars

#	Country	Overall GII (Score)	GII Rank	Input Innovation					Input Index	Output Innovation		Output Index
				Institutions	Human capital & research	Infrastructure	Market sophistication	Bus. sophistication		Know. and tec. outputs	Create. outputs	
1	Switzerland	67.5	1	3	4	7	5	4	2	1	1	1
2	Sweden	64.5	2	16	3	1	9	1	3	2	6	2
3	The U.S.	62.4	3	17	12	30	1	2	4	4	8	5
4	Singapore	61.2	4	1	2	11	7	3	1	9	19	11
5	U.K.	61.0	5	26	7	18	3	14	10	5	3	3

Source: WIPO, 2024

Figure 2 uses a bar graph to show GII 2024's five most innovative countries and their rank in the seven innovation pillars.

Figure 2: GII 2024 five most innovative countries and their rank in the seven innovation pillars

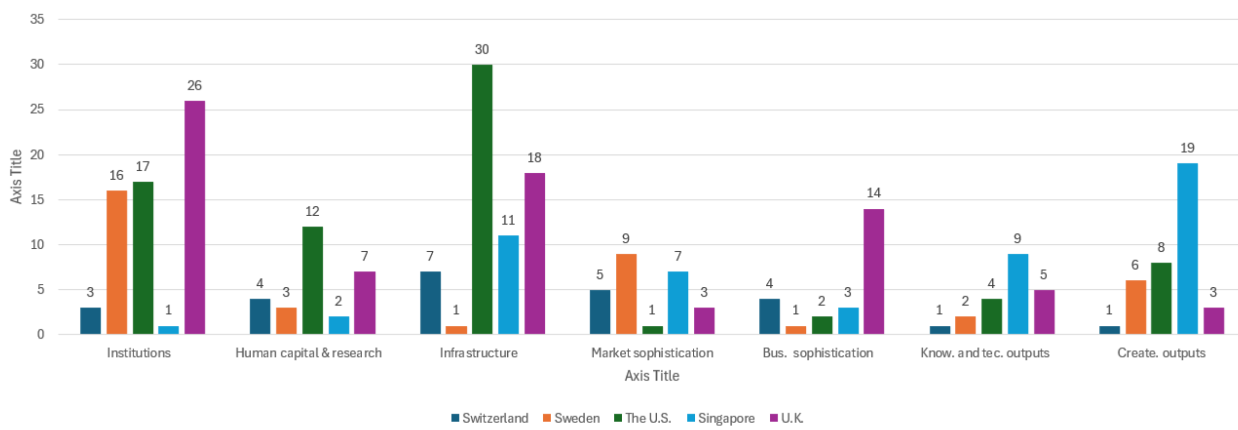


Table 3 reports the scores of the 21 sub-pillars of the five top innovative countries. A closer look at Table 3 discloses that the five countries ranked differently at the 21 sub-pillars, impacting their overall rankings. The five top innovative countries also differ in the number of GII innovation indicators (of the 21 sub-pillars) for which they ranked top. For instance, Singapore ranked first by scoring the highest in 14 out of 78 indicators; the U.S. ranked second by scoring top in 9 out of 78; and Switzerland ranked fourth by standing top in 7 out of 78 (WIPO, 2024). This finding suggests that although the cumulative scores enabled them to be in the top five innovative countries, they performed differently in the 78 GII innovation indicators.

Table 3. GII 2024 five most innovative countries: Rank and score in the 21 innovation sub-pillars

GII seven Pillars	*GII 21 Sub-pillars*	*Score/rank*	*The five most innovative countries*				
			Switzerland	*Sweden*	*The U.S.*	*Singapore*	*The U.K.*
Institutions	Institutional environment	Score	92.4	84.5	78.4	100.0	72.2
		Rank	4	12	21	1	32
	Regulatory environment	Score	89.2	89.2	81.2	97.4	83.7
		Rank	7	8	20	1	18
	Business environment	Rank	81.5	55.3	65.0	100.0	53.8
		Rank	3	45	25	1	50
Human capital and research	Education	Score	65.1	68.3	59.5	59.6	61.3
		Rank	14	8	40	39	32
	Tertiary education	Score	50.0	45.6	33.2	75.5	50.8
		Rank	14	24	67	2	12
	R&D	Rank	70.4	74.2	77.3	60.6	69.8
		Rank	4	3	2	14	5
Infrastructure	ICTs	Score	82.1	87.8	93.3	96.2	92.2
		Rank	40	15	9	3	11
	General infrastructure	Score	50.4	63.2	49.9	55.3	34.8
		Rank	15	6	17	12	51
	Ecological sustainability	Rank	49.9	50.6	13.7	18.7	38.0
		Rank	4	2	98	70	12
Market sophistication	Credit	Score	70.8	58.9	78.7	47.4	54.6
		Rank	4	12	3	27	17
	Investment	Score	64.9	57.7	69.9	88.6	61.5
		Rank	8	12	5	3	17
	Trade, diversification, and market scale	Rank	63.9	67.3	95.9	59.0	90.0
		Rank	33	25	1	56	5
Business sophistication	Knowledge workers	Score	71.2	80.4	81.8	71.1	69.4
		Rank	6	3	2	7	12
	Innovation linkages	Score	80.4	69.0	77.1	63.5	61.3
		Rank	1	4	2	7	11
	Knowledge absorption	Rank	50.1	72.8	52.8	71.4	38.6
		Rank	10	1	7	2	31
Knowledge and technology outputs	Knowledge creation	Score	78.7	74.6	56.9	39.9	59.1
		Rank	1	2	10	21	7
	Knowledge impact	Score	55.9	58.9	77.1	68.9	63.5
		Rank	7	6	1	2	3
	Knowledge diffusion	Rank	60.7	57.5	46.6	57.5	53.4
		Rank	2	6	16	5	12
Creative outputs	Intangible assets	Score	61.7	55.4	52.3	37.0	65.7
		Rank	9	12	18	41	7
	Creative goods and services	Score	59.7	49.9	49.1	48.6	50.4
		Rank	1	7	8	9	6
	Online creativity	Rank	85.4	70.4	65.9	67.1	63.3
		Rank	2	6	10	9	12

Source: WIPO, 2024

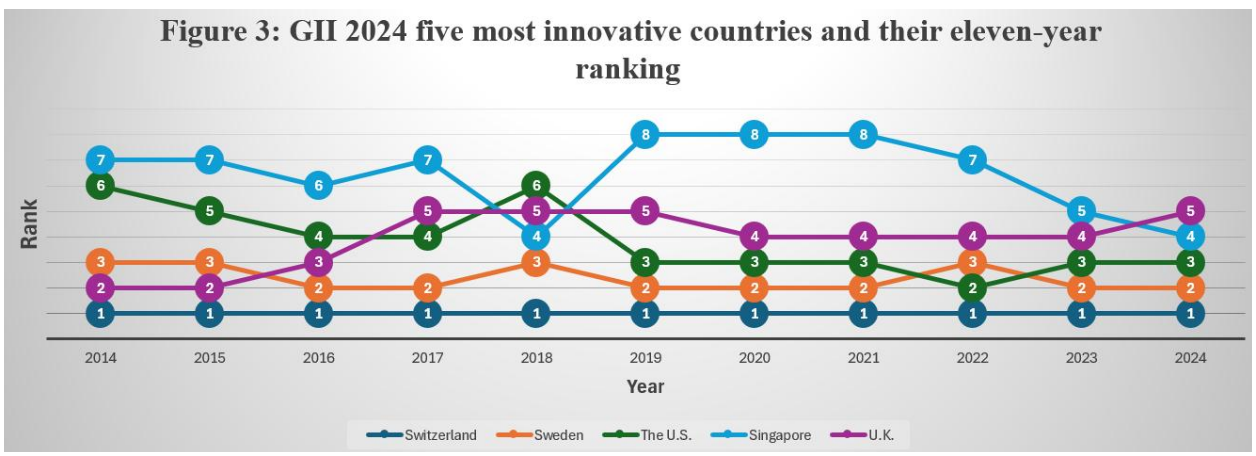
Table 4 reveals the eleven-year (2014-2024) ranking of the five sample countries based on overall GII scores. Except for Switzerland, the rankings of the four countries fluctuated. Switzerland has ranked first for the past eleven years. The U.S. and Sweden maintained their respective third and second positions for the second consecutive year (2023 and 2024). Sweden overtook the U.S., which was second in 2022 and climbed to the second position. Within the 5 most innovative countries, the top 3 remain unchanged (2023/2024), while Singapore advanced. While Singapore moved upward from eighth in 2021 to fourth in 2024, the U.K. moved downward from second in 2015 to fifth in 2024. Between 2014-2024, only Switzerland and Sweden stayed in the top three of the GII innovation ranking.

Table 4. GII 2024's five most innovative countries and their eleven-year (2014-2024) ranking

#	*Country*	*2014*	*2015*	*2016*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*
1	Switzerland	1	1	1	1	1	1	1	1	1	1	1
2	Sweden	3	3	2	2	3	2	2	2	3	2	2
3	The U.S.	6	5	4	4	6	3	3	3	2	3	3
4	Singapore	7	7	6	7	4	8	8	8	7	5	4
5	U.K.	2	2	3	5	5	5	4	4	4	4	5

Source: WIPO, 2014-2024 Global Innovation Index Database.

Figure 3 uses a line graph to show the GII 2024's five most innovative countries and their eleven-year (2014-2024) ranking.



6. Discussion

The five most innovative countries were developed countries: three from Europe, one from North America, and one from Asia. Their GDP per capita was above $56,000 (Table 1). This study, therefore, argues that the more developed a country is, the more likely it is to have favorable conditions for the seven GII pillars that impact its national innovation performance.

The overall findings of GII mostly align with existing research and prevailing theory in that the more countries score higher in the seven pillars (IISI & IOSI), the more they tend to be innovative countries (Hamid & Berrado, 2018; Huarng & Yu, 2022; Sohn & Kim, 2016).

This study indicates that, although the five countries had the highest overall GII scores, the scores of their seven GII pillars (Table 2) and sub-pillars (Table 3) differed. While some performed well in IISI pillars (e.g., Singapore), others performed well in IOSI pillars (e.g., Switzerland). One of the interesting findings of the current study is that the five countries were ranked as the top five most innovative countries, but each had a higher ranking in some GII pillars and not high in other aspects. It may indicate that each country has its strengths and weaknesses. It may also suggest they should not feel complacent about their ranking but should keep maintaining their good work and strive to improve on pillars ranked not high.

This study argues that, although Singapore performed well in input innovation, moving closer to the top 3 countries could be challenging because it lags in innovation output. While it ranked first in the input index, it ranked eleventh in the output index (Table 2). Thus, the gaps between the top 3 countries and Singapore remain huge in innovation outputs. Put differently, the top 3 countries performed well in most GII pillars and were able to balance their innovation inputs and outputs.

Switzerland ranked first for the 11th consecutive year (2014-2024) and remained the innovation leader (Table 4). The primary factor that made Switzerland the innovation leader is its outstanding achievement in innovation outputs, which have the highest weight in the GII calculation. It also scored reasonably high in innovation inputs, ranking in the top five of all the other GII pillars (Business sophistication and human capital and research, 4th; market sophistication, 5th; except for infrastructure, 7th) (Table 2).

The five most innovative countries have at least one agency that plays a critical role in national innovation. For instance, in Switzerland (e.g., Swiss Innovation Agency/Innosuisse and Swiss Federal Institute of Technology Zurich), Sweden (e.g., Vinnova and the Knowledge Foundation), the U.S. (e.g., the National Science Foundation and the National Institutes of Health), Singapore (e.g., The Ministry of Sustainability and the Environment and the National Environment Agency), the U.K. (e.g., Innovate UK and the UK Research and Innovation). They also have many universities known for their innovation. For example, Switzerland (e.g., ETH Zurich and University of Zurich), Sweden (e.g., Karolinska Institute and Chalmers University of Technology), the U.S. (e.g., Arizona State University and MIT), Singapore (e.g., Ngee Ann Polytechnic and Nanyang Technological University), and the U.K. (e.g., University of Oxford and University of Cambridge) (U.S. News, 2024). Moreover, they have many innovative companies that are known globally. For example, Switzerland (e.g., Nestlé, Novartis, Roche Group, and UBS AG), Sweden (e.g., Ericsson, Volvo, Geely Sweden Holdings, Hexagon, and Northvolt), the U.S. (e.g., Alphabet, Meta, Microsoft, and Apple), Singapore (e.g., SK Jewellery, Grab Holdings, Sintree Technology, and SingHealth), and the U.K. (e.g., AstraZeneca, British American Tobacco, and Unilever, and BP) (WIPO, 2024).

The governments of those countries played a vital role in promoting innovation through regulation, funding, collaboration, and strategic investments in various sectors and domains (Atkinson, 2014; Mowery & Rosengerg, 1993). Unlike neoclassical approaches to innovation policy, the governments of those five countries intervened and improved innovation capacities in their respective country by correcting systemic problems. Some of the systemic issues are those related to infrastructure (improved research and innovation infrastructure), capability (enhanced scientific and technological capabilities), and institutional (improved institutional frameworks for the innovation process). Moreover, those countries' triangular (government-industry-university cooperation) liaisons sparked technological innovation (Chaminade et al., 2018; Giusti et al., 2022). It could be argued that the three main actors in innovation systems (government, industry, and academia) in those five countries greatly influence the scores of their GII pillars (Table 2) and sub-pillars (Table 3). As a result, many companies in those countries have been competing successfully globally.

This study argues that translating a country’s investments in innovation (e.g., R&D, education, infrastructure, and institutions stimulating innovative activities) into innovation outputs is not easy. However, when governments are willing and able to create favorable conditions for the five pillars of input innovation, they are more likely to excel in successfully converting innovation inputs into outputs.

7. Conclusion, Implications, Limitations, and Directions for Research Directions

This study concluded that the input and output indexes, including the seven innovation pillars, are the main factors affecting the GII rankings. The 2024 GII rankings identified the five most innovative countries (Switzerland, Sweden, the U.S., Singapore, and the U.K.). Strong performance across all seven pillars has been seen among these countries. Hence, this study aligns with most prior studies in that the more countries perform well in the seven GII pillars, the more likely they are to be innovative.

This study offered insightful data on pillars/factors impacting the national innovation performance of the five most innovative nations in the GII 2024. The GII provides thorough data that can be used for scientific investigation and effective decision-making about the effective and efficient management of innovation. The innovation systems of the five countries are not the same because each is unique (e.g., culture, social, political, population size, geographic location) and should be understood in this context. However, the effectiveness of their seven pillars of innovation significantly impacted the performance of their respective innovation systems.

Measuring innovation outputs and their outcomes is not an easy task because the innovation process is complex. Hence, the GII captures the multi-dimensional facets of innovation by assessing the climate, institutions, and infrastructure for innovation and evaluating associated outcomes.

The governments of the five most innovative countries put innovation at the center of their growth strategies and played critical roles directly or indirectly in almost all seven GII pillars of innovation by correcting systemic problems and facilitating the networks among actors who make up the innovation system. The effective interactions and collaborations among the several actors involved in the generation, diffusion, and adoption of innovation were great.

This study contends that countries could achieve high innovation performance when they put favorable conditions for the seven GII pillars in place and put innovation at the center of their national agenda. Acknowledging and celebrating innovation can be vital for inspiring populations, specifically the future entrepreneurs and innovators. Innovation is essential for economic growth and development and is crucial to building a sustainable and resilient future. The effectiveness of nations' innovation systems can be a critical factor in assisting countries to compete and win in the global innovation race.

This study concluded that the rankings of those five countries, except Switzerland, fluctuated over the past eleven years. They all have strengths and weaknesses. Therefore, the challenge for them is whether they will maintain their strengths and work on their weaknesses to remain among the top five innovative countries in the future.

This study provided empirical evidence about the factors that influence national innovation performance. It argued that although other factors may affect a nation's innovation success, the seven GII pillars are vital. An important lesson to be learned from the experiences of the five most innovative countries is that countries need to perform well in the seven GII pillars to improve their national innovation performance. Countries also need to use the GII data. It can be used to closely monitor progress, identify strengths and weaknesses, and strategize to improve their innovation potential, ultimately enhancing their competitiveness.

This study is a valuable addition to the literature on NIS in general and the GII in particular, as it examines the factors that made the five countries the most innovative and the similarities and differences in their innovation activities and performance. This study expands our knowledge of the GII, which is recognized as an effective tool for comparing national innovation performance. This study complements previous studies on NIS in general and the GII in particular.

This research is subject to certain constraints. First, it focused on the five most innovative countries. Future research should compare the seven GII pillars of the most innovative, average, and low-performing countries. Second, because this study utilized cross-sectional data from the 2024 GII, subsequent investigations should adopt longitudinal methodologies to evaluate these variables over an extended period. Using longitudinal data can help track changes in the performance of the seven GII pillars and overall rankings over time. Furthermore, since there is limited empirical knowledge on innovation input and output relationships in developing countries, future research needs to examine how much the five pillars of innovation input affect the two pillars of output innovation using GII data.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Publication Ethics Committee of Sciedu Press.

The journal and publisher adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

Not commissioned; externally double-blind peer reviewed.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

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