The determinants of innovation performance: an income-based cross-country comparative analysis using the Global Innovation Index (GII)

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Abstract

Despite the dearth of research on innovation, the key determinants of innovation performance still need to be clarified. Besides, a comparative analysis of the determinants of innovation performance across countries at different income levels has yet to be found. This study, therefore, aims to bridge this research gap by considering the innovation performance of 63 countries. Participating countries were purposefully selected from the Global Innovation Index (GII) dataset. Multistage and multimodal analyses were conducted, including multiple linear regressions, hierarchical regression, and ANOVA, to examine the variation in innovation performance and pinpoint critical determinants in each category of countries. The result reveals that human capital, research, infrastructure, and business sophistication are the key pillars determining countries' innovation performance. In a variable-level analysis, innovation linkage and knowledge absorption (both of business sophistication), research and development (R&D), and infrastructure (inculcating both physical and digital) are the best predicting variables. The shortage of human capital to promote R&D is the biggest bottleneck hampering innovation in the lower-middle-income category. Also, both human capital for R&D activities and innovation linkage equally affect the upper-middle-income, and the latter one, innovation linkage, remains the main challenge even for the high-income category. The study implies that innovation performance predicts a country's economic growth. The level of innovation performance and the determinants of innovation vary per the countries' income levels. Accordingly, countries and firms in various income categories should prioritize tackling their respective bottlenecks hindering innovation performance in their policy directions. The study claims to have extended the horizon of understanding determinants of innovation across countries and revealed the most crucial factors in each category of countries. Further empirical comparative research can be done by incorporating an informal institution, national culture, as an additional determinant and specifying sectors across income categories.

Keywords: Innovation, Innovation inputs, Innovation outputs, Determinants of innovation, Business sophistication, Market sophistication, Institutions, Infrastructure, Human capital, R&D

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Introduction

Innovation has been defined as introducing new products or services, new processes, opening new markets, and using new resources to create value in the market (Obunike & Udu, 2019; Wang & Ahmed, 2017). Scholars classify innovation as technological and non-technological innovativeness (Rahman et al., 2016; Tseng, 2014). Combining technological and non-technological innovation makes businesses more competitive (Zawawi et al., 2016). According to Pisano (2015), there are four types of innovation: disruptive, architectural, routine, and radical. Damanpour and Wischnevsky (2006) argue that businesses and startups should focus more on radical innovation, while large firms should focus more on routine or incremental innovation to gain competitive advantage.

In general, new business ventures are regarded as the driver of innovation and wealth creation. New and relatively small firms can be seen as the primary engine for employment opportunities, incentives for innovation, job creation, and the improvement of the well-being of the residents (Sembiring, 2016; Tsatsenko et al., 2020). Hence, countries encourage the growth of these small and new firms to reduce unemployment and poverty. Small and medium-sized enterprises (SMEs) represent 99% of all businesses in the EU (European Commission, 2020). This signals the fact that the competitiveness and innovativeness of countries primarily emanate from these firms. Smith (1993) argues that it is not a nation that is powerful but firms that run business in its territory. It can also be argued that it is not a country that is innovative but firms, especially SMEs, that operate under its jurisdiction.

Despite their overwhelming share and contribution towards economic development and employment, the firms face a multifaceted challenge of innovation to stay afloat. These challenges are internal to organizations and external from institutional, micro-, and macro-level factors. The level of innovation in small or new businesses determines either their success or failure (Frambach, 1993). Notably, most small or new companies fail to innovate (Ndesaulwa & Kikula, 2016). This failure to innovate has implications such as reduced competitiveness, less awareness of environmental changes, and innovative solutions, resulting in poor performance (Farsi & Toghraee, 2015; Hausman, 2005). Firms' failure to innovate results in a nation losing its competitive advantage from innovation. For countries to remain competitive, firms must continuously innovate to ensure that their products or services match the changing technology and markets (Hutt & Speh, 2010; Pisano, 2015). The role of innovation in stimulating the economic growth of both developing and developed countries is indispensable (Barrichello et al., 2020). Hence, it needs a valid account of innovation performance to improve it. However, no single set of measures is commonly entertained and countries' innovation performance has been measured in various ways. Contrary to the previous research (such as Hsu et al., 2014; Qureshi et al., 2021; Stern et al., 2000; Ulku, 2004) that only used the size of patent applications to measure innovation performance, the present study adopts a diverse set of measures ranging from knowledge and technology outputs to creative outputs of innovation from Global Innovation Index (GEI).

Previous literature has also focused on determinants of innovation (Barrichello et al., 2020; Protogerou et al., 2017; Qureshi et al., 2021), innovation challenges per country (Farsi & Toghraee, 2015; Uvarova & Vitola, 2019), dynamics of innovation (Sharif et al., 2021). However, despite the dearth of research on innovation, the key determinants

or inputs of innovation still need to be clarified. Also, as per the current researchers' knowledge, a comparative study on the determinants of innovation performance among country groups at different income levels: high-income, upper-middle-income, lower-middle-income, and low-income countries, whose classification is based on the World Bank, is barely found.

This study, therefore, aims to bridge this research gap by considering the innovation performance of 63 countries. Its objectives can be summarized as follows: *to identify the key pillars of innovation based on GEI, to determine the best predicting model or the key determinants (inputs) of innovation, and to analyze an income-based cross-country variation in innovation performance.* Multistage analyses were conducted using multiple linear regression, hierarchical regression, and ANOVA models. The results indicate that human capital and research, infrastructure, and business sophistication as the key pillars determining innovation performance. The study further reveals that the lack of human capital that promotes R&D is the biggest bottleneck that hampers innovation in a lower-middle-income category, whereas both innovation linkage and human capital that promotes R&D in an upper-middle-income category and innovation linkage in a high-income category. The remaining sections of the paper consecutively present the literature review, methodology, data analysis and results, discussion and conclusion, and implication and limitation.

Literature review and hypothesis development

Determinants of innovation

The genre of innovation has been widely studied since the 1970s. Early researchers focused on the concept of innovation and scales for the measurements (Hurt et al., 1977; Midgley & Dowling, 1978; Subramanian & Nilakanta, 1996). Consequently, research on innovation broadened to areas such as customer innovativeness, the impact of innovativeness (Hult et al., 2004; Roehrich, 2004; Venkatraman, 1991), and determinants of innovation (Bhattacharya & Bloch, 2004; Romijn & Albaladejo, 2002).

Furthermore, academic scholars expand their research on the determinants of innovation. For instance, Pertuz et. al. (2018) argue that organizational structures, work climate, knowledge development, and human resource well-being are some factors that determine the innovation capacity of medium-sized firms. Additionally, Restrepo-Morales et al. (2019) identified R&D activities and alliances as the determinants of the innovativeness of SMEs in Colombia. At the same time, Babuchowska and Marks-Bielska (2021) reveal that streamlining work, improvement in quality, and compliance with the requirements as some of the determinants of innovation in dairy farms in Poland. Moreover, Kireyeva et al. (2021) identify the company's age, type, sector, R&D, and technology as positively influencing the organization's tendency to innovate. Interestingly, competitors in the market and the location (region) negatively influence the tendency to innovate (Kireyeva et al., 2021). Innovation remains an essential component of the competitiveness of companies. Table 1 shows the empirical studies on determinants of innovation and measures of innovation performance in different countries.

One can conclude from this that the significant determinants of countries' innovation performance are lack of appropriate innovation policies (Uvarova & Vitola, 2019), lack of skills and knowledge in innovation (Farsi & Toghraee, 2015; Qureshi

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Table 1 Empirical analysis of the determinants of innovation

Studies	Measures of innovation	Country coverage	Key findings	Firm size/type
Sudolska and Łapińska (2020)	Innovation outputs	Poland	The innovation capability is determined by inter-organization capability, hiring employees in R&D, and increasing firms' internal expenditure on R&D	Manufacturing sectors
Ndesaulwa and Kikula (2016)	Infrastructure, R&D Market conditions	Tanzania	SMEs in these countries face the challenge of gaining entrance into new markets, and their presence in the market has little or no influence on the market prices as larger firms influence their market prices	SMEs
Uvarova and Vitola (2019)	Policies Knowledge and skills Cooperation and networking	European countries	Inappropriate innovation policies, lack of skills and knowledge, inability to hire a skilled workforce, inadequacies in the environment for innovation and competitiveness	Rural SMEs
Agwu (2014)	Infrastructure Skills	Nigeria	Inadequate social infrastructures, taxation, inadequate financing, and lack of managerial skills	SMEs
Gachara (2017)	Knowledge Resources Technology Regulations and policy	Kenya	Knowledge challenges, resources challenges, technology challenges, legal and policies challenges, and environmental challenges faced by SMEs in both developed and developing countries	SMEs
Stern et. al. (2000)	International patents granted by the USA patent office	17 OECD countries	R&D human resources and spending policies such as intellectual property, trade, openness, the share of research by the academic sector, and knowledge stock characterize innovative capacity	Both large and SMEs

Table 1 (continued)

Studies	Measures of innovation	Country coverage	Key findings	Firm size/type
Ulku (2004)	Patent applications	20 OECD and ten non-OECD countries	There is a significant relationship between R&D stock and innovation. Innovation rates increase when investment in R&D increases	Both large and SMEs
Hsu et. al. (2014)	Patent counts, patent citations, and R&D expenses	32 developed and emerging countries	Higher innovation is the result of high-tech intensive and external finance	Financial markets
Qureshi et. al. (2021)	Patent flows (number of patent applications by residents, world development indicators)	Asia and Pacific region and Latin America, and the Caribbean	R&D, human capital, infrastructure access, and financial development have a positive effect	Both large and small business
Grego-Planer and Kus (2020)	Innovative activity of enterprise (dichotomous response, 0, 1)	Poland	Workforce mobility and work ethic, like workaholics, negatively affect innovation People's level of education, management attitude towards innovation, corporate image and reputation, and technological development positively influence	202 small Polish businesses
Farsi and Toghraee (2015)	Human capital R&D Infrastructure Regulation	Iran	A wide range of innovative challenges, such as human resources, research, and development, emerging new technologies, regulatory and inadequate market information	SMEs

Source: Authors' creation, 2021

et al., 2021; Uvarova & Vitola, 2019); spending policies on research and development (R&D) (Farsi & Toghraee, 2015; Qureshi et al., 2021; Stern et al., 2000; Sudolska & Łapińska, 2020); intellectual property, trade, and openness (Stern et al., 2000); lack of knowledge sharing and market information Farsi & Toghraee, 2015; Gachara, 2017); legal and regulatory issues (Farsi & Toghraee, 2015; Gachara, 2017); and access to infrastructure (Agwu, 2014; Qureshi et al., 2021). Corroborating these findings, the Global innovation index, which is applied to the current study, categorizes all the determinants of innovation under the five pillars: institutions, human capital and research, infrastructure, market sophistication, and business sophistication. Then, they are hypothesized with innovation outputs in the following section.

Hypothesis development

Though various sources, as shown in Table 1, reveal a diverse set of determinants of innovation, the Global Innovation Index, which is adopted for this study, summarizes them all under five pillars: institutions, human capital and research, infrastructure, market sophistication, and business sophistication. Tracing the literature, the association between these pillars and innovation performance is hypothesized in the succeeding subsections.

Institutions and innovation performance

Institutions can be either formal or informal (Minto-Coy & McNaughton, 2016; Okrah & Hajduk-Stelmachowicz, 2020). Property rights, contracts, policies, regulations, laws, and constitutions are formal institutions, while informal institutions refer to the culture and societal norms that rule the operations of businesses (Berman, 2013; Minto-Coy & McNaughton, 2016). A country with weak institutional factors or where the institutional factors put in place are not considered hinders innovation by deteriorating the confidence of the investors, customers, and industries (Jovovic et al., 2017; Szalacha-Jarmużek & Pietrowicz, 2018). Additionally, the political environment of a country determines the efficiency of innovation. Hence, increasing the investment attractiveness of locally owned firms with local authorities' assistance helps create a good connection for innovation (Yachmeneva & Vol's'ka, 2014).

According to Oluwatobi et. al. (2016), the quality of institutions (government effectiveness, political stability, the rule of law, and regulatory quality) affects innovation output in Sub Sahara Africa. In support of these findings, a study by Okrah and Hajduk-Stelmachowicz (2020) concludes that suitable institutional environments foster innovativeness. A favorable political climate encourages small businesses and entrepreneurs to explore various opportunities. At the same time, the people's confidence in their political system encourages innovativeness (Okrah & Hajduk-Stelmachowicz, 2020). Moreover, a sound legal and regulatory structure fosters the growth and innovativeness of small businesses (Nyarku & Oduro, 2018). Further, a study by Wang et al. (2020a) reveals that Chinese firms with high government affiliations are more innovative than others. They also argued that the influence of government on innovativeness is primarily related to the intensity of the protection of intellectual property by legal institutions (Wang et al., 2020a, 2020b). Based on these facts, we hypothesize as follows:

H1   There is a statistically significant effect and positive relationship between institutions and innovation performance.

Human capital, research and development, and innovation performance

Competent human capital with educational background and adequate skills are essential for developing new and young businesses. Primary education and continuous investment in the development of human resources are necessary to motivate innovativeness, especially for new companies. According to Oluwatobi et al. (2016),

human capital is an essential determinant of innovation across countries. You et al. (2021) argue that human capital stimulates innovation since education improves employee skills and their ability to acquire knowledge. Moreover, educated employees combine the knowledge acquired in education uniquely to achieve innovation (You et al., 2021).

Research reveals a positive relationship between human capital and innovativeness. For example, Farace and Mazzotta (2015) concludes that there is a positive relationship between human capital and the innovativeness of SMEs in Italy. This argument was in line with Protogerou et. al. (2017) study, which found previous exposure to R&D, educational background, and team diversity as internal factors that determine the innovativeness of young European firms. The study by Wang et. al. (2020a, 2020b) reveals that human capital and R&D are essential factors that explain innovativeness, particularly technological innovation in advanced economies. At the same time, Qureshi et al. (2021) found a positive and significant relationship between R&D and innovation in Asia–Pacific but not in Latin America and the Caribbean. The study also found a positive effect of education on innovation in Asia–Pacific, Latin America, and Caribbean countries (Qureshi et al., 2021). Additionally, You et. al. (2021) finds a positive effect of human capital on a firm's innovation in China, and increasing state R&D expenditures encourages the innovation capability of domestic companies and withstand foreign companies' competition (Vasvári et al., 2019). Therefore, relying on these facts, we hypothesize as follows:

H2   There is a statistically significant effect and positive relationship between human capital and innovation performance.

Infrastructure and innovation performance

A healthy and established technological and physical infrastructure is essential in enhancing the innovation of businesses. According to Pan et al. (2021), a conducive technology infrastructure boosts technological innovation and then promotes countries' economic development. Also, Jabbouri et al. (2016) found a positive and significant relationship between technological infrastructure and innovation performance in Iraq. Tsetim et al. (2020) indicate that infrastructural dimensions, which include technology and structure, had a significant relation to the innovativeness of SMEs in Nigeria. Besides, Qureshi et al. (2021) argue a positive and significant relationship between infrastructure access and innovation in Asia–Pacific but not in Latin America and the Caribbean. In China, Pan et al. (2021) pinpoint an inverted U-type nonlinear influence of technology infrastructure on the local innovation capability. In the following hypothesis, we tested this contested result by considering countries income levels and regions:

H3   There is a statistically significant effect and positive relationship between infrastructure and innovation performance.

Market sophistication and innovation performance

This study views market sophistication regarding the availability of credit facilities that support businesses' innovation, access to international markets, competition, and the ease of protecting small investors from being overtaken by foreign businesses. New businesses face intense competitive pressure from large and established firms. Therefore, they should focus more on innovation to deal with the challenge of the ever-changing and dynamic business environment (Bate, 2019). Organizational innovativeness is benchmarked against competitors to develop unique products (Im & Workman, 2004). Additionally, continuous benchmarking with rival companies heightens innovativeness (Pesämaa et al., 2013).

Despite the competition, small and new businesses, especially in developed countries, are challenged to access credit (Giang et al., 2019). Academic scholars have argued that access to finance plays a vital role in the innovativeness of firms (Fernandez, 2017; Osano & Languitone, 2015). Related literature by Wellalage and Fernandez (2019) on innovation and SME finance in developing countries revealed a positive relationship between financing (formal and informal) and the innovativeness (product and process) of a firm. Against this background, the current study aims to investigate the relationship between market sophistication and the innovativeness of firms and the following hypothesis tested:

H4   There is a statistically significant effect and positive relationship between market sophistication and innovation performance.

Business sophistication and innovation performance

This study views business sophistication regarding knowledge workers, innovation linkages, and knowledge absorption. Razavi et al. (2012) and Dima et al. (2018) refer to business sophistication as the quality of business networks, strategies, and operations. In line with this, Kirikkaleli and Ozun (2019) argue that business sophistication focuses on the general quality of the country's business networks and the quality of individual business strategies and operations. Moreover, business sophistication can be viewed in terms of the Knowledge workers that enhance and commercialize innovation. Knowledge is a crucial element in the development and growth of businesses across the globe. In the current era of globalization, investing in a more knowledgeable workforce and managing this knowledge (Hassan & Raziq, 2019) gives businesses a competitive advantage in innovation. According to Kirikkaleli and Ozun (2019), business sophistication and innovation are essential components of competitiveness in innovation-driven economies.

Razavi et. al. (2012) found a significant positive relationship between innovation and business sophistication. Protogerou et. al. (2017) revealed that external factors such as technology collaborations and networking with universities are crucial in explaining the innovation of young firms in Europe. Additionally, the interconnection of businesses with government and research institutions and customers can be considered the most significant linkages that boost innovation (Ayman and Asad 2022; Ortega & Serna, 2020). Also, Kirikkaleli and Ozun (2019) found a positive link between business

sophistication and innovation capacity in OECD countries. Following this argument, we hypothesize as follows:

H5   There is a statistically significant relationship between business sophistication and innovation performance.

Per capita income and innovation performance

According to Zanello et. al. (2016), the intensity of innovation, types of innovation, and determinants of innovation vary based on the country's context and its level of development. For instance, in low-income countries, the assimilation and adoption of new technologies are essential foundations for innovation. This has been furtherly explained by Qureshi et. al. (2021) that R&D has a positive and significant effect on innovation in the Asia–Pacific region but not in Latin America and the Caribbean countries. Besides, infrastructure access positively influences innovation only in Asia and the Pacific region, whereas financial development affects innovation only in Latin America and the Caribbean. Education level is the only variable that significantly affects innovation in both regions. Therefore, this study is intended to investigate the variation of determinants based on the level of economic development: lower-middle-income, upper-middle-income, and high-income countries and hypothesize as follows:

H6   There is a statistically significant variation in determinants of innovation among countries with different income levels.

H6a   There is a statistically significant variation of determinants of innovation between lower-middle-income and upper-middle-income countries.

H6b   There is a statistically significant variation of determinants of innovation between upper-middle-income and high-income countries.

Methodology

The study applies a quantitative research design. The cross-sectional data were obtained from the World Intellectual Property Organization (WIPO): Global Innovation Index (GII) (2020). The analysis was made at the country level to identify the determinants of innovation from national perspectives. The country-level data of the index allows investigating the inputs of innovation, which are commonly known as determinants of innovation, on one side and the outputs of innovation on the other. The country selection was based on data accuracy in the dataset to incorporate only those countries with the required data for the measurement. A total of 63 (48% of 131 countries) countries, see Additional file 1: Table S1, have been included in the study and represent all economic levels and regions in the world. Multiple linear regression was run to identify significant determinants at the pillar level and their effect on innovation outputs.

In order to determine the best predicting model, the hierarchical multiple regression analysis was conducted with the standard stepping method criteria (the probability
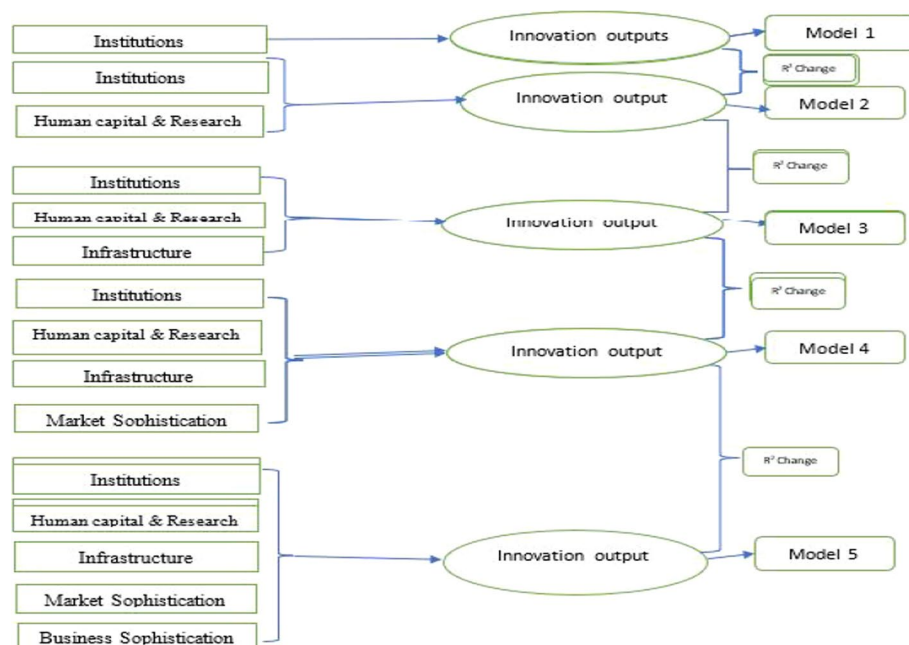
Fig. 1 The prototype of the hierarchical multiple regression models (Source: Authors' work, 2022)

of F is equal to 0.05 for entry and 0.1 for removal) at the variable level. To analyze the effect of relatively highly correlated independent variables and multiplicative terms in regression analysis, hierarchical multiple regression is an appropriate tool (Wiklund & Shepherd, 2005). In a hierarchical analysis, starting with a conventional multiple linear regression, the next higher order of interaction is added, which could consequently be two-way, or three-way interactions. Then, the incremental R^2 and F tests of statistical significance are evaluated. The interaction effect is considered if, and only if, the interaction value shows a statistically significant contribution over and above the direct effects of the previously entered independent variables (Cohen, 1977). As a principle, we pursued this approach in the current study to find the best predicting model that shows the critical determinants of innovation. The assessment of how significant interactions affect the dependent variable is done by entering selected values of the interaction terms into the regression equation. Following this, we came up with five models, which depend on the size of independent variables. We assessed the interaction effect in each model (see Fig. 1, for the prototype of the modeling).

Besides, one-way ANOVA was conducted to single out the variation of innovation input and output performance among countries in three income-based groups. The bottleneck in each category is identified and illustrated in the histogram.

Variable description

Contrary to previous research (such as Hsu et al., 2014; Qureshi et al., 2021; Stern et al., 2000; Ulku, 2004) that only used the size of patent applications to measure innovation performance, this study adopts a diverse set of measures ranging from knowledge creation to knowledge diffusion to gauge innovation performance. The knowledge creation includes patent applications by origin, patent cooperation treaty applications,

Table 2 Variable description

Variable category	Pillars	Variables/items	Source
Independent variable	Institutions	Political environment	World Intellectual Property Organization (WIPO): Global Innovation Index
		Regulatory environment	
		Business environment	
	Human capital and research	Education	
		Tertiary education	
		Research and development	
	Infrastructure	Information and communication technology (ICT)	
		General infrastructure that includes utilities like electricity	
		Ecological sustainability	
	Market sophistication	Investment	
		Credit system	
		Trade, competition, and market scale	
	Business sophistication	Knowledge workers	
		Innovation linkage	
		Knowledge absorption	
Dependent variable	Knowledge and technology outputs	Knowledge creation	World Intellectual Property Organization (WIPO): Global Innovation Index
		Knowledge impact	
		Knowledge diffusion	
	Creative outputs of innovation	Intangible assets that include patents and copyrights	
		Creative goods and services	
		Online creativity	
Extraneous variable	Income-level of countries	High-income level	World Bank Data: economies by per capita GNI in June 2019
		Upper-middle income	
		Lower-middle-income	
		Low income	

Source: Authors' creation, 2021

utility models (petty or short-term patents) by origin, scientific and technical publications, and citable documents *H*-index. Knowledge diffusion incorporates intellectual property receipts, high-tech exports, ICT exports, and foreign direct investment net outflows. The innovation output is also measured regarding knowledge impact that addresses GDP growth rate per person employed, new business density, ISO 9001 quality certificates, and high-tech and medium-tech manufacturing. Hence, this study not only applies, but also overarches the recommendation by Ortega and Serna (2020), which says the research on innovation performance should measure the size of patents and their impact. Below, Table 2 displays the pillars and items for both dependent and independent variables.

Model specification

To keep the validity and reduce measurement error, the data accuracy has been given prime attention in selecting the subjects for the analysis. Since the dependent variable is continuous, it allows applying regression analysis. There is no multicollinearity

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Table 3 Hypotheses testing result

Hypotheses	Decision
H1. There is a statistically significant effect and positive relationship between institutions and innovativeness	Rejected
H2. There is a statistically significant effect and positive relationship between human capital and innovativeness	Partially accepted because there is a positive correlation but not a significant effect
H3. There is a statistically significant relationship between infrastructure and innovativeness	Partially accepted because there is a positive correlation but not a significant effect
H4. There is a statistically significant effect and positive relationship between market sophistication and innovativeness	Partially accepted because there is a positive correlation but not a significant effect
H5. There is a statistically significant effect and positive relationship between business sophistication and innovativeness	Accepted

Source: Authors' estimates, 2021

Table 4 Regression coefficients of pillar innovation inputs and innovation output sub-index

Model	Unstandardized coefficients		Standardized coefficients	T	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
1 (Constant)	− 5.878	4.339		− 1.355	0.181			
Institutions	− 0.029	0.110	− 0.033	− 0.263	0.793	0.792	− 0.035	− 0.013
Human capital and research	0.015	0.089	0.017	0.169	0.866	0.788	0.022	0.008
Infrastructure	0.238	0.149	0.185	1.600	0.115	0.807	0.207	0.078
Market sophistication	0.031	0.080	0.030	0.389	0.699	0.662	0.051	0.019
Business sophistication	0.671	0.083	0.767	8.087	0.000	0.924	0.731	0.393

Source: Own analysis, 2021

Dependent variable: innovation output sub-index

detected among independent variables. The correlation coefficients in Table 4 show that the 'r-value of all independent variables is less than 0.9. Also, it is proven that collinearity diagnostics show variance inflation factor (VIF) is less than ten, and the 'Tolerance' values for all independent variables are more than 0.1, which accords with the rule of thumb. Due to less sample size relative to the number of independent variables and the perceived considerable variation of performance among participating countries, the standardized coefficients and R square adjusted have been emphasized. Five models were run using hierarchical multiple regression to determine a robust model with the highest predictive power against the dependent variables.

Data presentation and analysis

This section is subdivided into four sections: first, the analysis of hypotheses testing results is presented; second, the determinants of knowledge and technology outputs of innovation; next, the determinants of creative outputs of innovation; and, in the end, the analysis of variance (ANOVA) based on per capita income of countries are presented.

Hypotheses testing results

Below, Table 3 indicates the hypotheses test results, while Table 4 shows us the effect of inputs of innovation and their relationship with innovation outputs. The regression model significantly predicts 86.6% of innovation outputs. The zero-order or the Pearson correlation coefficients indicate that all the pillar inputs: institutions, human capital and research, infrastructure access, and business sophistication, have a solid and positive relationship with innovation output with an R-value of 0.7, except market sophistication ($r = 0.662$). However, we should examine partial and part correlation to control the effect of other independent variables and single out the relationship between each independent variable and innovation outputs. In this regard, all pillars, except business sophistication, show a weak correlation with innovation outputs with an r value less than 0.3 as a cut-off point. Also, all the pillars' unique contribution or effect is insignificant, except for business sophistication ($p = 0.000$, $B = 0.671$). Based on this result, our hypothesis test goes as follows:

Business sophistication positively correlates to and substantially explains about 76.7% of innovation outputs, which is the only significant pillar here (Table 4). It means that a unit change in business sophistication increases a country's innovation output by 76.7%. Except for institutions, all others have a positive effect on innovation. In H1, the institution has no unique significant effect on innovation outputs. As the variables incorporated in each of these pillars are diverse, the item or variable-level analysis is needed, which was done in the upcoming section. In the like manner, to better understand and explain the partial acceptance of H2, H3, and H4, a variable-level analysis needs to do. Subsequently, the ANOVA was utilized to determine whether countries' income levels might have influenced the result.

Analysis of the determinants of innovation and knowledge and technology outputs

The determinants of innovation, such as political environment, research and development, knowledge workers, innovation linkages, and knowledge absorption, have shown strong positive correlations ($r > 0.7$) with knowledge and technology outputs. In contrast, tertiary education and ecological sustainability have shown weak correlations of 'r-value of 0.33 and 0.426, respectively (Additional file 1: Table S4). Model 6 in the model summary, Table 5, indicates the best approximate prediction values on the dependent variable. The model includes all predicting variables (business environment, regulatory environment, political environment, tertiary education, education, research, and development (R&D), ecological sustainability, general infrastructure, information, and communication technologies (ICTs), investment, trade, competition and market scale, credit, knowledge absorption, innovation linkages), except knowledge workers. These variables in the model explain about 84% (adjusted $R^2 = 0.836$) of knowledge and technology outputs with the least value of error (5:5237) and (R^2 change $= 0.12$, $p = 0.035$). As shown in the ANOVA Additional file 1: Table S3, with a p-value of 0.000, the model makes a statistically significant variance in predicting the dependent variable.

The regression coefficient, Table 6 below shows that knowledge absorption ($p = 0.000$, beta $= 0.447$), research and development (R&D) ($p = 0.036$, beta $= 0.331$), and innovation linkages ($p = 0.035$, beta $= 0.260$) are, consecutively, the highest and statistically

Table 5 Model summary of knowledge and technology outputs

Model summary[f]									Df2	Sign.
Model	**R**	**R square**	**Adjusted R square**	**Std. the error of the estimate**	**Change statistics**					
					R square change	**F change**	**df1**			
1	0.736[a]	0.542	0.519	9.4572	0.542	23.290	3		59	0.000
2	0.848[b]	0.719	0.689	7.6057	0.177	11.740	3		56	0.000
3	0.865[c]	0.748	0.705	7.4002	0.029	2.051	3		53	0.118
4	0.871[d]	0.759	0.701	7.4539	0.011	0.746	3		50	0.530
5	0.934[e]	0.873	0.836	5.5237	0.012	4.711	1		48	0.035

[a] Predictors: (constant), business environment, regulatory environment, political environment

[b] Predictors: (constant), business environment, regulatory environment, political environment, tertiary education, education, research and development (R&D)

[c] Predictors: (constant), business environment, regulatory environment, political environment, tertiary education, education, research and development (R&D), ecological sustainability, general infrastructure, information and communication technologies (ICTs)

[d] Predictors: (constant), business environment, regulatory environment, political environment, tertiary education, education, research and development (R&D), ecological sustainability, general infrastructure, information and communication technologies (ICTs), investment, trade, competition and market scale, credit

[e] Predictors: (constant), business environment, regulatory environment, political environment, tertiary education, education, research and development (R&D), ecological sustainability, general infrastructure, information and communication technologies (ICTs), investment, trade, Competition and market scale, credit, knowledge absorption, innovation linkages

[f] Dependent variable: knowledge and technology outputs

Table 6 Regression coefficients of the predictors of knowledge and technology output

Coefficients								
Model	**Unstandardized coefficients**		**Standardized coefficients**	**T**	**Sig.**	**Correlations**		
	B	**Std. error**	**Beta**			**Zero-order**	**Partial**	**Part**
5 (Constant)	− 18.831	11.326		− 1.663	0.103			
Political environment	− 0.188	0.130	− 0.233	− 1.453	0.153	0.728	− 0.205	− 0.075
Regulatory environment	0.086	0.108	0.101	0.789	0.434	0.633	0.113	0.041
Business environment	0.117	0.126	0.089	0.928	0.358	0.612	0.133	0.048
Education	0.174	0.112	0.138	1.551	0.127	0.514	0.218	0.080
Tertiary education	0.006	0.068	0.006	0.092	0.927	0.339	0.013	0.005
Research and development (R&D)	0.179	0.083	0.331	2.155	0.036	0.831	0.297	0.111
ICTs	− 0.218	0.148	− 0.216	− 1.473	0.147	0.671	− 0.208	− 0.076
General infrastructure	0.015	0.110	0.013	0.137	0.892	0.556	0.020	0.007
Ecological sustainability	0.174	0.093	0.142	1.875	0.067	0.426	0.261	0.096
Credit	0.008	0.068	0.011	0.115	0.909	0.573	0.017	0.006
Investment	0.027	0.096	0.024	0.277	0.783	0.574	0.040	0.014
Trade, competition and market scale	0.172	0.133	0.122	1.295	0.202	0.495	0.184	0.067
Knowledge absorption	0.529	0.103	0.447	5.114	0.000	0.823	0.594	0.263
Innovation linkages	0.226	0.104	0.260	2.171	0.035	0.791	0.299	0.112

[a] Dependent variable: knowledge and technology outputs

Table 7 Model summary for creative outputs

Model summary[f]

Model	R	R square	Adjusted R square	Std. error of the estimate	Change statistics				
					R square change	F change	df1	df2	sign F change
1	0.829[a]	0.688	0.683	6.0752	0.688	134.538	1	61	0.000
2	0.845[b]	0.714	0.695	5.9621	0.026	1.779	3	58	0.161
3	0.868[c]	0.754	0.722	5.6866	0.039	2.918	3	55	0.042
4	0.870[d]	0.757	0.711	5.8043	0.004	0.264	3	52	0.851
5	0.893[e]	0.797	0.753	5.3640	0.039	9.887	1	51	0.003

[a] Predictors: (constant), political environment

[b] Predictors: (constant), political environment, tertiary education, education, R&D

[c] Predictors: (constant), political environment, tertiary education, education, R&D, ecological sustainability, general infrastructure, ICTs

[d] Predictors: (constant), political environment, tertiary education, education, R&D, ecological sustainability, general infrastructure, ICTs, investment, trade, competition and market scale, credit

[e] Predictors: (constant), political environment, tertiary education, education, R&D, ecological sustainability, general infrastructure, ICTs, investment, trade, competition and market scale, credit, innovation linkages

[f] Dependent variable: creative outputs

significant predictors of knowledge and technology outputs. These variables are also seen with their strong zero-order correlation coefficients and shallow 'tolerance' values that all support their unique association and indispensable roles in the knowledge and technology outputs. Both knowledge absorption and innovation linkages refer to the business sophistication pillar. At the pillar level analysis, the same pillar alone explains about 83% (beta$=82.6\%$, $p=0.000$) of knowledge and technology outputs (Additional file [1]: Table S5).

In the first step, when entering variables only from the institution, the political environment is the strongest and statistically significant predictor of knowledge and technology outputs with $p=0.003$ and beta$=0.603$. In the next step, when coupled with variables from human capital and research, the political environment loses its significant position, and R&D becomes the only strongest and unique predictor by explaining 69.4% ($p=0.000$, beta$=0.694$) of knowledge and technology outputs. In the third step, further integration with infrastructure variables, the predictive power of R&D is increased to 78.9%, whereas ecological sustainability explains 23.2% (beta$=0.232$ $p=0.018$) statistically significantly. However, the *R* square change (0.029) is statistically insignificant with a *p*-value of 0.118, as shown in Additional file [1]: Table S4. Likewise, the R^2 change of the fourth model is also insignificant, and none of the added market sophistication variables (credit, investment, trade, competition and market scale) play a statistically significant and unique role in explaining knowledge and technology outputs. Finally, in the last sixth model, R&D, knowledge absorption, and innovation linkages have statistically significant and unique contributions with the highest R^2 value. Throughout the models tested, R&D has maintained its statistically significant position in uniquely predicting innovation's knowledge and technology outputs (see Table [6]).

Table 8 The regression coefficient of predictors of creative outputs

Coefficients[a]

Model	Unstandardized coefficients		Standardized coefficients	T	Sig.	Correlations		
	B	Std. error	Beta			Zero-order	Partial	Part
5 (Constant)	− 14.908	10.360		− 1.439	0.156			
Political environment	0.159	0.120	0.249	1.322	0.192	0.829	0.182	0.084
Education	0.166	0.106	0.167	1.568	0.123	0.642	0.214	0.099
Tertiary education	− 0.042	0.065	− 0.051	− 0.645	0.522	0.366	− 0.090	− 0.041
R&D	− 0.069	0.079	− 0.160	− 0.862	0.393	0.685	− 0.120	− 0.054
ICTs	0.129	0.130	0.161	0.992	0.326	0.740	0.138	0.063
General infrastructure	0.120	0.100	0.126	1.201	0.235	0.453	0.166	0.076
Ecological sustainability	0.185	0.087	0.192	2.130	0.038	0.605	0.286	0.134
Credit	− 0.002	0.060	− 0.003	− 0.028	0.978	0.586	− 0.004	− 0.002
Investment	− 0.032	0.092	− 0.036	− 0.344	0.732	0.483	− 0.048	− 0.022
Trade, competition and market scale	0.051	0.118	0.046	0.433	0.667	0.255	0.061	0.027
Innovation linkages	0.298	0.095	0.433	3.144	0.003	0.754	0.403	0.199

[a] Dependent variable: creative outputs

Analysis of determinants of innovation and creative outputs

As shown in Table 8, except trade, competition and market scale ($r = 0.255$, $p = 0.022$), tertiary education ($r = 0.366$, $p = 0.002$), and general infrastructure ($r = 0.453$, $p = 0.000$), all other independent variables have a strong and positive correlation with creative outputs. Like it does to knowledge and technology outputs, tertiary education has also shown a weak correlation ($r = 0.366$) with creative innovation outputs. Among the regression models (see Table 7), model 5 gives the best prediction. About 75.3% ($p = 0.000$, sign *F* Change $= 0.003$) of creative outputs are explained by the political environment, tertiary education, education, R&D, ecological sustainability, general infrastructure, ICTs, investment, trade, competition and market scale, credit, and innovation linkages. In this model, the regulatory environment and business environment from a pillar of institution and knowledge workers and knowledge absorption from the business sophistication pillar are removed by the system due to the initial stepping method criteria.

The political environment is the only predictor among the institution pillar variables that explain creative outputs statistically significantly in the first model in the absence of variables from other pillars. However, in both dependent variables' cases, when coupled with variables from all other pillars, their unique contribution to creative outputs has become statistically insignificant (beta $= 0.249$, $p = 0.129$). The two statistically significant predictors of creative outputs are innovation linkages (beta $= 0.433$, $p = 0.003$) and ecological sustainability (beta $= 0.192$, $p = 0.038$) (see Table 8 and Additional file 1: Table S8). At a pillar level, creative outputs strongly correlate with infrastructure ($r = 0.805$, $p = 0.000$) and business sophistication ($r = 0.850$,

Table 9 Hypotheses test results

No	Hypothesis	Decision
H6a:	There is a statistically significant variation in determinants of innovation among countries with different income levels	Accepted
H6b:	There is a statistically significant variation in determinants of innovation between lower-middle-income and upper-middle-income countries	Partially accepted
H6c:	There is a statistically significant variation of determinants of innovation between upper-middle-income and high-income countries	Accepted

Source: own study result, 2021

$p = 0.000$). All the pillars (institution, human capital, research, infrastructure, market sophistication, and business sophistication) collectively explain about 76% [R adjusted square $= 0.758$, with a sign. F change $= 0.000$ and ANOVA $p = 0.000$ (Additional file 1: Table S7)]. However, in this model, only business sophistication (beta $= 0.608$, $p = 0.000$) has a statistically significant effect on creative outputs.

Analysis of variance (ANOVA) based on the per capita income of countries

The countries included in the study are grouped into four based on World Bank's income-based country classification[1]: high-income (1), upper-middle income (2), lower-middle-income countries (3), and low-income countries (4). This study emphasizes the first three categories. For economic growth variance analysis, the pillars of independent pillars are considered: institution, education and research, infrastructure, market sophistication, and business sophistication. The analysis also considers the performance of countries in both innovation outputs: knowledge and technology outputs and creative outputs. Subsequently, other variable or item level analysis is also done to substantiate the variance among countries.

Levene's test uses an 'F-test' to test the null hypothesis, assuming the variance is equal across groups. A 'p' value less than 0.05 indicates a violation of the assumption (Statistics Solutions, 2013). In the test of homogeneity of variance, Additional file 1: Table S9, innovation input sub-index in general and institutions and business sophistication pillars violate the assumption of the F-test and show that the three groups of countries are statistically at a different level of performance. ANOVA result (Additional file 1: Table S10) is consistent with this, and means of innovation performance significantly vary within a group and across groups. Specifically, the post hoc tests of Tukey HSD (Additional file 1: Table S11) show that institutions, access to infrastructure, human capital, and research are significantly different across three groups of countries. The three variables are in the same category under homogeneous subsets (Additional file 1: Table S12).

In a one-to-one comparison, the tests show no significant difference between upper-middle and high-income countries in terms of innovation output index in general and market sophistication and business sophistication innovation input performance. On the other side, the performance of these innovation inputs does not statistically significantly differ between upper-middle-income and lower-middle-income.

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[1] Source: World Bank, country classification by income (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519).

In Table 9, above, H6a clearly shows that the determinants of innovation that affect the innovation outputs in a high-income country may not work for an upper-middle-income or a lower-middle-income country, and vice versa. In H6b, we partially accept this hypothesis because some of the determinants of innovation, such as business and market sophistication, do not show a remarkable difference between lower-middle and upper-middle-income countries. However, on the other side, we see the intensity and importance of determinants of innovation, such as institutions, infrastructure, and human capital, and research, significantly differ between these groups.

We accept the H6c hypothesis because, as shown in ANOVA (Additional file 1: Table S10) and post hoc tests, Additional file 1: Table S10, there is a statistically significant difference between upper-middle-income countries and high-income countries in the performance of all the variables: institutions, infrastructure, human capital, and research and market sophistication and business sophistication. It means that a determinant of innovation in upper-middle-income countries may not exist at all or may not affect the innovation performance in high-income countries with the same intensity.

Discussion

At the pillar level, our hypothesis (H1) that postulates a statistically significant effect and positive relationship between institutions and innovation performance was rejected. Of course, this does not mean institutions do not play decisive roles in innovation. However, it could be understood in such a way that role of the institution in innovation is less compared to other pillars (infrastructure, human capital and research, market sophistication, and business sophistication). Also, our further variable-level analysis reveals that variables of institution pillars such as business environment, regulatory environment, and political environment are in a set of variables in the best predicting model of innovation and also supported by previous findings (Jovovic et al., 2017; Szalacha-Jarmużek & Pietrowicz, 2018; Udimal et al., 2019). Hence, instead of treating the institution pillar in general terms, it would be preferable to treat it at a variable level.

Supporting H5, business sophistication positively correlates to and substantially explains (67%) innovation outputs. It is the only statistically significant pillar and explains about 83% of knowledge and technology outputs and 60.8% of creative outputs of innovation. Knowledge absorption and innovation linkages are the business sophistication variables that significantly contribute to knowledge and technology outputs. It is consistent with previous findings that indicate a significant relationship between knowledge management and innovation of firms (Hadhri et al., 2016; Price et al., 2013). A free flow of knowledge among employees, stakeholders, and other institutions is crucial to generate new ideas, products, or services (Bate, 2019). Especially the innovation linkages among government, research institutions, and customers are the most significant linkages that boost innovativeness (Hadhri et al., 2016). In line with this, the level of interaction with different parties, especially academic partners, is the key determinant to boosting the innovation performance of the developing country (Bate, 2021; Hadhri et al., 2016; Ortega & Serna, 2020; Qureshi et al., 2021). An industry perspective study by Giones (2019) unfolds that university-industry collaborations can be enhanced by training that focuses on attitude change of firm owners, innovation vouchers, and grants by a university.

Among pillars, human capital, research, and business sophistication are decisive in predicting knowledge and technology outputs. As shown by hierarchical regression, a proper set of the business, regulatory, and political environment; tertiary education, and research, and development (R&D); ecological sustainability concern; general infrastructure, information, and communication technologies (ICTs); investment, trade, competition and market scale, and credit system; knowledge absorption, and innovation linkages is the best model to predict and enhance knowledge and technology outputs of innovation. An ample of previous studies also support this model. For example, the credit system (Giang et al., 2019), access to finance (Fernandez, 2017; Osano & Languitone, 2015), academic knowledge and skills of human resources (Bate, 2021; Farsi & Toghraee, 2015; Uvarova & Vitola, 2019; You et al., 2021) play an essential role in the innovativeness of firms. Also, partnership and technology transfer and R&D activities (Hadhri et al., 2016; Qureshi et al., 2021), the pace of technological development, and the population's educational level (Grego-Planer & Kus, 2020) accelerate innovation, Weak institutions deteriorate the confidence of the investors, customers, and industries (Jovovic et al., 2017; Szalacha-Jarmużek & Pietrowicz, 2018). Technological infrastructure that includes mobile phones, internet access, online platforms, and digital workshops are believed to have a tremendous effect on the innovativeness of SMEs in all business areas (Bate, 2021; ITC, 2018; Oyedele et al., 2014). In a regulatory environment, maintaining institutions like property rights essentially encourages firms to engage more in the innovation of new products in developing countries (Udimal et al., 2019).

Among these factors, the study further reveals that knowledge absorption, research and development, and innovation linkages, respectively, are the highest and statistically significant predictors of knowledge and technology outputs of innovation. In accord with this, several researchers have proved that R&D and researchers are essential ingredients to enable and increase innovation performance (Farsi & Toghraee, 2015; Hadhri et al., 2016; Qureshi et al., 2021; Ulku, 2004). Hadhri et. al. (2016) pinpointed a solid relationship between R&D activities and innovation. They further explained that firms those spend more on R&D activities innovate more in service, product, and process; whereas Mustafa and Yaakub (2018) argue that technology adoption as the key to enhance company performance. In the study covering several countries from Asia- the Pacific region and Latin America and the Caribbean, Qureshi et. al. (2021) find R&D, human capital, and infrastructure access, among others, as the key determinants of innovation.

As happened to knowledge and technology outputs, innovation linkage is the main variable under business sophistication contributing to creative outputs of innovation. At the pillar level, business sophistication and access to infrastructure are the two crucial and statistically significant pillars to enhancing the creative outputs of innovation. Especially infrastructure that ensures ecological sustainability is highly demanded, and therefore, it shows that utilities, including energy alternatives or electricity, machinery, or transportation, are needed to be eco-friendly, which scales up the need for innovation. Also, the result pinpoints that, since almost all the variables are the same, the model that best predicts knowledge and technology outputs can also be applied to explain creative outputs. Hence, to accelerate innovation (including both knowledge and technology outputs and creative outputs), the desired effort need to be appropriated to all these factors: integrating business,

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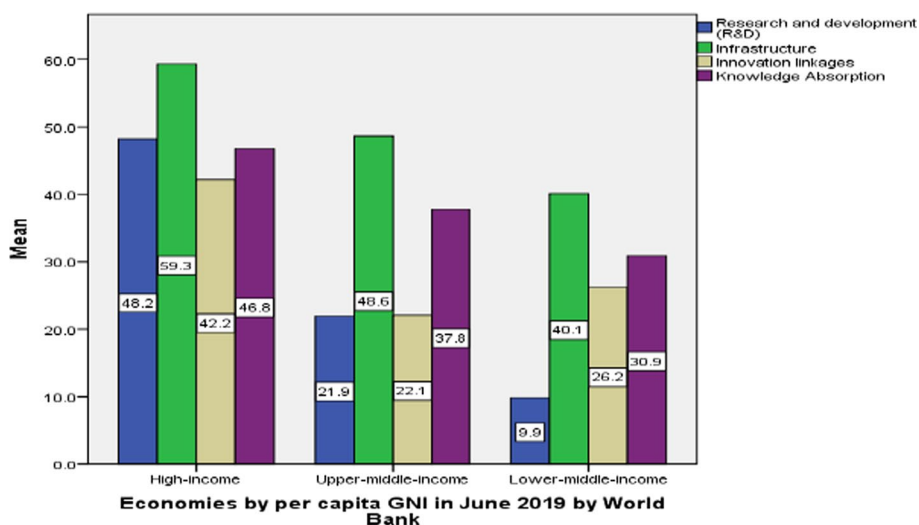
Fig. 2 Innovation activities as per countries' income level (Source: Own study result, 2021)

regulatory, and political environment; advancing tertiary education, and R&D; improving ecological sustainability, general infrastructure, and ICTs; sophisticating investment and trade, competition and market scale, credit system; and ensuring knowledge absorption, and innovation linkages. Moreover, the results imply that innovation linkages, knowledge absorption, infrastructure, and research and development exert preponderant influence on innovation performance and may need to draw the utmost priority, including extra budget allocation. This supplements the argument made by Hadhri et. al. (2016), Protogerou et. al. (2017), Ortega and Serna (2020), and Ćudić et. al. (2022) as they argue that technology collaborations and networking with universities, interconnection with government, research institutions, and customers are the most significant linkages to boost innovation.

However, as shown by the hypothesis (H6a) testing result, the innovation determinants in a high-income country do not equally work for an upper-middle-income or a lower-middle-income country, and vice versa. Even if the determinants are the same in all groups, the level of priority and importance in predicting innovation performance is not the same. Further analysis, the histogram illustration below, reveals the difference in the performance status of the groups and the bottleneck/s of each group, where poor performance is observed (Fig. 2).

Therefore, the lower-middle-income countries are expected to prioritize human capital and research (mainly focus on R&D activities), business sophistication (primarily focus on innovation linkages followed by knowledge absorption), and infrastructure, respectively. Those studies conducted in lower-middle-income countries such as Iran (Farsi & Toghraee, 2015), Asian countries including India, Vietnam, Bangladesh, and Sri Lanka (Qureshi et al., 2021), Nigeria (Agwu, 2014), Ethiopia (Ayinaddis, 2022) and Gulf Cooperation Council Countries (Chun-Yao, 2014) prove that human capital that promotes R&D and infrastructure is found to be the key to flourish the innovation. The upper-middle-income countries are expected to

equally consider both bottlenecks—R&D and innovation linkage, and then consecutively pursue knowledge absorption and infrastructure. It also shows that innovation linkage is a bottleneck where the high-income countries lag. Therefore, the countries and firms in the high-income category must prioritize innovation linkage, knowledge absorption, R&D, and infrastructure, consecutively, to boost their innovation performance.

Conclusion and implications

The study data were collected from World Intellectual Property Organization (WIPO) and the World Bank country classification website. A total of 63 (48% of 131) countries were purposefully selected from Global Innovation Index (GII) participating countries to minimize errors related to measurement and data validity by incorporating countries with complete data or missing very little data. Multistage analyses were conducted in which the underlying hypotheses on the determinants of innovation were tested. First, multiple linear regression was conducted on innovation inputs to identify the most predicting pillars: a hierarchical regression was conducted to identify the best predicting model of innovation performance based on variables; the one-way ANOVA analysis was applied to examine the level of effect and significance of the selected determinants in the countries at different income levels. The three most essential pillars for innovation are business sophistication, human capital and research, and infrastructure. The business sophistication pillar contributes most significantly to both knowledge and technology outputs and the creative outputs of innovation. Especially knowledge absorption and innovation linkages variables significantly contribute to innovation in general. The other most essential variables are research and development (R&D) and infrastructure that considers ecological sustainability.

The best predicting model of determinants of innovation performance should consider how to integrate business and political environment; advance tertiary education, and research and development (R&D); enhance ecological sustainability and build general infrastructure, information, and communication technologies (ICTs); sophisticate investment and trade, credit system, competition and market scale; and ensure knowledge absorption, and innovation linkages. Among these, the most decisive factors are human capital, R&D activities, innovation linkages, knowledge absorption, and infrastructure. Their effect and significance to innovation outputs vary based on countries' income levels, and countries should prioritize the bottleneck determinants in which they poorly perform or lag. Hence, high-income countries must focus on innovation linkage, knowledge absorption, human capital that promotes R&D, and infrastructure, consecutively. Whereas firms and countries in the upper-middle-income category can equally prioritize and invest in human capital that promotes R&D and innovation linkage, then knowledge absorption comes, followed by infrastructure. The lower-middle-income category must prioritize human capital that promotes R&D activities since it is the biggest bottleneck, followed by innovation linkages, knowledge absorption, and infrastructure, consecutively.

Managerial or policy implications

The study results benefit stakeholders, including policymakers, development and financial agents, venture capitalists, donors, business incubators, researchers, and governments, who foster innovation efforts within a country or across countries. The study result implies that innovation performance is one of the main factors in explaining the variation of countries' economic growth, considering per capita income. Besides, the key factors should be identified and prioritized in each category of countries based on the importance of lagging variables. Countries and firms in an upper-middle-income category are expected to give equal attention to R&D and innovation linkage at a time, then go for knowledge absorption followed by infrastructure. In contrast, countries and firms in a high-income category need to focus on innovation linkage, knowledge absorption, R&D, and infrastructure, consecutively to further advance their innovation performance. This implies that infrastructure access is not the main bottleneck to all countries and firms, especially in the upper-middle-income and high-income categories. Those countries and firms in the lower-middle-income category should not directly imitate what all upper-middle or high-income countries do regarding innovation. They should first work on human capital that promotes R&D activities by providing sufficient funds, as also previously suggested by Ayinaddis (2022).

Without reliable R&D activities, innovation problems cannot be easily defined; if the problems are not identified well, an attempt to bring innovative solutions may not bring the desired results. Following this, the firms and countries of the lower-middle-income could work on innovation linkage. Innovation linkage can be any public/private/academic partnership that bolsters innovation in creating a joint venture or deals or sharing innovative resources, knowledge, skills, and experience within a country or abroad. It includes developing clusters (geographic concentration of firms, suppliers, or producers of related products), patent families filed in two offices, and university/industry research collaboration (Global Innovation Index, 2020). The university–industry collaborative innovation linkage can be enhanced by training that focuses on the attitudinal change of businesses, providing innovation vouchers, and grants from a university (Giones, 2019) and facilitating both paid and unpaid internships and apprenticeships for students and staffs to work with industry owners.

Following this, the lower-middle-income countries could work on knowledge absorption and infrastructure. Knowledge absorption refers to an organizational capability to integrate, transfer and utilize new knowledge from external sources. Innovation linkage can be a means for knowledge absorption. Knowledge can flow in and out via the linkage created with different partners, including institutions, customers, suppliers, competitors, and dealers. Thus, it needs a proper strategy for firms to absorb this knowledge and then commercialize it. The strategies may include creating shared digital platforms, research forums, seminars and conferences, and workshops, exchanging resources, including materials and machinery, and giving access to employees for on-the-job and off-the-job training and experience-sharing opportunities. Finally, to commercialize this knowledge, access to infrastructure (both physical and digital infrastructure) is vital, and proper action should be taken to improve the infrastructure in each business unit or sector.

Theoretical implications

The current study strengthens the findings of the previous research that lack of skills and knowledge in innovation (Farsi & Toghraee, 2015; Qureshi et al., 2021; Uvarova & Vitola, 2019), spending policies on research and development (R&D) (Ayinaddis, 2022; Farsi & Toghraee, 2015; Stern et al., 2000; Sudolska & Łapińska, 2020; Qureshi et al., 2021), lack of knowledge sharing and market information (Farsi & Toghraee, 2015; Gachara, 2017), legal and regulatory issues (Farsi & Toghraee, 2015; Gachara, 2017), and access to infrastructure (Agwu, 2014; Qureshi et al., 2021) are the critical determinants of innovation. It also re-boosts the findings of Protogerou et. al. (2017), Ortega and Serna (2020), and Ćudić et. al. (2022), who argue that technology collaborations and networking with universities, inter-connection with government, research institutions, and customers are the most significant linkages to boost innovation. Moreover, the current study lays groundwork and extends the horizon of theoretical knowledge in understanding the determinants of innovation in categories of countries at different income levels, instead of focusing on individual countries.

As a limitation, the study does not distinguish the innovation performance based on the size of firms. Hence, further research can be done on how these determinants of innovation separately affect SMEs and large businesses in four categories of countries: high-income, upper-middle-income, lower-middle-income, and low-income category. The current study considers the five pillars of GII: institutions, human capital and research, infrastructure, market sophistication, and business sophistication. Since it didn't consider informal institutions (national culture), future research should incorporate the latter as one of the determinants and analyze how significantly it predicts innovation along with other pillars. The current study analyzes the overall innovation performance across country groups, without stratifying based on sectors or industries, therefore future research can make specific sector-wise comparative analysis on innovation performance across countries at different income levels.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13731-023-00283-2.

Additional file 1: Table S1. Per-capita income based country classification (subjects of this study). **Table S2.** Model summary of knowledge and technology outputs. **Table S3.** ANOVA of models. **Table S4.** Regression coefficients of the predictors of knowledge and technology output. **Table S5.** Regression coefficients of pillar against knowledge & technology outputs of innovation. **Table S6.** Model summary for creative outputs. **Table S7.** ANOVA for models of creative output and its predictors. **Table S8.** Regression coefficient of predictors of creative outputs. **Table S9.** Test of homogeneity of variance. **Table S10.** ANOVA table for percapita income and determinants. **Table S11.** Post hoc tests: multiple comparisons. **Table S12.** Homogeneous subsets.

Availability of data and materials
The dataset of the study can be accessed from the public website of the world intellectual property organization, Global Innovation Index2020: https://www.wipo.int/global_innovation_index/en/.

Declarations

References

Agwu, M. O. (2014). Issues, challenges and prospects of small and medium scale enterprises (SMEs) in Port-Harcourt city. *European Journal of Sustainable Development, 3*(1), 101–114. https://doi.org/10.14207/ejsd.2014.v3n1p101

Ayinaddis, S. G. (2022). Exploring firm-specific deterrents of innovation in micro and small enterprises in Ethiopia. *Journal of Innovation and Entrepreneurship, 11*(1), 1–13. https://doi.org/10.1186/s13731-022-00256-x

Ayman, B., & Asad, A. (2022). How can companies pursue better strategies through innovation? A review of various perspectives on innovation, competitiveness, and technology. *International Journal of Operations and Quantitative Management, 28*(1), 280–294. https://doi.org/10.46970/2022.28.1.16

Babuchowska, K., & Marks-Bielska, R. (2021). Determinants of innovation in diary farms in Poland. *European Research Studies Journal, XXIV*(1), 1240–1249. https://doi.org/10.35808/ersj/2021

Barrichello, A., Paulo, S., De Política, E. P., Negócios, E., & Morano, R. S. (2020). Determinant and priority factors of innovation for the development of nations. *Innovation & Management Review, 17*(3), 307–320. https://doi.org/10.1108/INMR-04-2019-0040

Bate, A. F. (2019). The effect of market orientation and entrepreneurial orientation on new product development. *The Hungarian Journal of Marketing and Management, 53*(2), 45–53. https://doi.org/10.15170/MM.2019.53.02.04

Bate, A. F. (2021). A comparative analysis on the entrepreneurial ecosystem of BRICS club countries: Practical emphasis on South Africa. *SN Business & Economics, 1*(10), 121. https://doi.org/10.1007/s43546-021-00120-2

Berman, S. (2013). Ideational theorizing in the social sciences since 'policy paradigms, social learning and the state.' *Governance, 26*(2), 217–237.

Bhattacharya, M., & Bloch, H. (2004). Determinants of innovation. *Small Business Economics, 22*(2), 155–162. https://doi.org/10.1023/B:SBEJ.0000014453.94445.de

Cohen, J. (1977). Statistical power analysis for the behavioral sciences (Rev. ed.). Lawrence Erlbaum Associates, Inc

Chun-Yao, T. (2014). Technological innovation capability, knowledge sourcing and collaborative innovation in Gulf Cooperation Council countries. *Innovation, 16*(2), 212–223. https://doi.org/10.1080/14479338.2014.11081983

Ćudić, B., Alešnik, P., & Hazemali, D. (2022). Factors impacting university–industry collaboration in European countries. *Journal of Innovation and Entrepreneurship, 11*(1), 33. https://doi.org/10.1186/s13731-022-00226-3

Damanpour, F., & Wischnevsky, J. (2006). Research on innovation in organizations: Distinguishing innovation-generating from innovation-adopting organizations. *Journal of Engineering and Technology Management, 23*, 269–291. https://doi.org/10.1016/j.jengtecman.2006.08.002

Dima, A. M., Begu, L., Vasilescu, M. D., & Maassen, M. A. (2018). The relationship between the knowledge economy and global competitiveness in the European Union. *Sustainability (switzerland), 10*(6), 1706. https://doi.org/10.3390/su10061706

European Commission. (2020). *Internal market, industry, entrepreneurship, and SMEs*. Retrieved January 20, 2022, from https://ec.europa.eu/growth/smes/sme-definition_en

Farace, S., & Mazzotta, F. (2015). The effect of human capital and networks on the effect of human capital and networks on knowledge and innovation in SMEs 1. *Journal of Innovation Economics & Management*. https://doi.org/10.3917/jie.016.0039

Farsi, J. Y., & Toghraee, M. T. (2015). Erratum to: Identification of the main challenges of small and medium-sized enterprises in exploiting innovative opportunities (case study: Iran SMEs). *Journal of Global Entrepreneurship Research*. https://doi.org/10.1186/s40497-015-0030-y

Fernandez, V. (2017). The finance of innovation in Latin America. *Journal of International Review of Financial Analysis, 53*, 37–47.

Frambach, R. T. (1993). An integrated model of organizational adoption and diffusion of innovations. *European Journal of Marketing, 27*(5), 22–41. https://doi.org/10.1108/03090569310039705

Gachara, H. N. (2017). Innovation challenges encountered by small and medium enterprises in Nairobi, Kenya. *International Journal of Economics, Commerce and Management, VI*(6), 717–738.

Giang, M. H., Trung, B. H., Yoshida, Y., Xuan, T. D., & Que, M. T. (2019). The causal effect of access to finance on the productivity of small and medium enterprises in Vietnam. *Sustainability (switzerland), 11*(19), 1–19. https://doi.org/10.3390/su11195451

Giones, F. (2019). University-industry collaborations: An industry perspective. *Management Decision, 57*(12), 3258–3279. https://doi.org/10.1108/md-11-2018-1182

Global Innovation Index (GII). (2020). Global innovation index: Resources, Wipo. int. Retrieved October 01, 2020, from https://www.wipo.int/global_innovation_index/en/

Grego-Planer, D., & Kus, A. (2020). Determinants of innovation activities in small enterprises: A model approach. *European Research Studies Journal, XXIII*(Special Issue 1), 137–148. https://doi.org/10.35808/ersj/1750

Hadhri, W., Arvanitis, R., & M'Henni, H. (2016). Determinants of innovation activities in small and open economies: The Lebanese business sector. *Journal of Innovation Economics, 21*(3), 77. https://doi.org/10.3917/jie.021.0077

Hassan, N., & Raziq, A. (2019). Effects of knowledge management practices on innovation in SMEs. *Management Science Letters, 9*(7), 997–1008. https://doi.org/10.5267/j.msl.2019.4.005

Hausman, A. (2005). Innovativeness among small businesses: Theory and propositions for future research. *Industrial Marketing Management, 34*(8), 773–782. https://doi.org/10.1016/j.indmarman.2004.12.009

Hsu, P.-H., Xuan, T., & Yan, X. (2014). Financial development and innovation: Cross-country evidence. *Journal of Financial Economics, 112*(1), 116–135.

Hurt, H. Y., Joseph, K., & Cook, C. D. (1977). Scales for the measurement of innovativeness. *Human Communication Research, 4*, 58–65.

Hult, G. T. M., Hurley, R. F., & Knight, G. A. (2004). Innovativeness: Its antecedents and impact on business performance. *Industrial Marketing Management, 33*(5), 429–438. https://doi.org/10.1016/j.indmarman.2003.08.015

Hutt, M. D., & Speh, T. W. (2010). Business marketing management: B2B. Mason, Ohio U.S.A. South-Western/Cengage Learning.

Im, S., & Workman, J. P. (2004). Market orientation, creativity, and new product performance in high-technology firms. *Journal of Marketing, 68*(2), 114–132. https://doi.org/10.1509/jmkg.68.2.114.27788

ITC. (2018). *Promoting SME competitiveness in Africa: Data for de-risking investment.* ITC.

Jabbouri, N. I., Siron, R., Zahari, I., & Khalid, M. (2016). Impact of information technology infrastructure on innovation performance: An empirical study on private universities in Iraq. *Procedia Economics and Finance, 39*(November 2015), 861–869. https://doi.org/10.1016/s2212-5671(16)30250-7

Jovovic, R., Draskovic, M., Delibasic, M., & Jovovic, M. (2017). The concept of sustainable regional development—Institutional aspects, policies, and prospects. *Journal of International Studies, 10*(1), 255–266. https://doi.org/10.14254/2071-8330.2017/10-1/18

Midgley, D. F., & Dowling, G. R. (1978). Innovativeness: The Concept and Its Measurement. *Journal of Consumer Research, 4*(4), 229. https://doi.org/10.1086/208701

Kireyeva, A., Nurbatsin, A., Yessentay, A., Bagayeva, N., & Sharbanu, T. (2021). Exploring determinants of innovation potential of enterprises in Kazakhstan. *Problems and Perspectives in Management, 19*(2), 433–443. https://doi.org/10.21511/ppm.19(2).2021.34

Kirikkaleli, D., & Ozun, A. (2019). Innovation capacity, business sophistication, and macroeconomic stability: Empirical evidence from OECD countries. *Journal of Business Economics and Management, 20*(2), 351–367. https://doi.org/10.3846/jbem.2019.9602

Minto-Coy, I., & McNaughton, M. (2016). Barriers to entrepreneurship and innovation: An institutional analysis of mobile banking in Jamaica and Kenya. *Social and Economic Studies, 65*(2), 99–131.

Mustafa, H. K., & Yaakub, S. (2018). Innovation and technology adoption challenges: Impact on SMEs' company. *International Journal of Accounting, Finance, and Business, 3*(15), 57–65.

Ndesaulwa, A. P., & Kikula, J. (2016). The impact of innovation on performance of small and medium enterprises (SMEs) in Tanzania: A review of empirical evidence. *Journal of Business and Management Sciences, 4*(1), 1–6. https://doi.org/10.12691/jbms-4-1-1

Nyarku, K. M., & Oduro, S. (2018). Effect of legal and regulatory framework on SMEs growth in the Accra Metropolis of Ghana. *International Journal of Entrepreneurship and Innovation, 19*(3), 207–217. https://doi.org/10.1177/1465750317742842

Obunike, C. F., & Udu, A. A. (2019). Technological innovativeness and growth: A study of small scale manufacturing firms in Lagos State, Nigeria. *Economics of Development, 17*, 39–53. https://doi.org/10.21511/ed.17(4).2018.05

Okrah, J., & Hajduk-Stelmachowicz, M. (2020). Political stability and innovation in Africa. *Journal of International Studies, 13*(1), 234–246. https://doi.org/10.14254/2071-8330.2020/13-1/15

Oluwatobi, S., Ola-david, O., Olurinola, I., Alege, P., & Ogundipe, A. (2016). Human capital, institutions and innovation in sub-Saharan Africa. *International Journal of Economics and Financial Issues, 6*(4), 1507–1514.

Ortega, A. M., & Serna, M. (2020). Determinants of innovation performance of organizations in a regional innovation system from a developing country. *International Journal of Innovation Science, 12*(3), 345–362. https://doi.org/10.1108/IJIS-03-2020-0023

Osano, H. M., & Languitone, H. (2015). Factors influencing access to finance by SMEs in Mozambique: The case of SMEs in Maputo central business district. *Journal of Innovation and Entrepreneurship, 5*(1), 1–16. https://doi.org/10.1186/s13731-016-0041-0

Oyedele, M., Kabuoh, M., Oduyoye, O., Olalekan, A., & Elemo, G. (2014). On entrepreneurial success of small and medium enterprises (SMEs): A conceptual and theoretical framework. *Journal of Economics and Sustainable Development, 5*(16), 14–24.

Pan, X., Guo, S., Li, M., & Song, J. (2021). The effect of technology infrastructure investment on technological innovation—A study based on the spatial Durbin model. *Technovation, 107*(April), 102315. https://doi.org/10.1016/j.technovation.2021.102315

Pertuz, V. P., Perez, A. B., & Geizzelez, M. L. (2018). Determinants of innovation capacity in medium-sized firms. *Journal of Physics: Conference Series, 1126*(1), 012060. https://doi.org/10.1088/1742-6596/1126/1/012060

Pesämaa, O., Shoham, A., Wincent, J., & Ruvio, A. A. (2013). How a learning orientation affects drivers of innovativeness and performance in service delivery. *Journal of Engineering and Technology Management - JET-M, 30*(2), 169–187. https://doi.org/10.1016/j.jengtecman.2013.01.004

Pisano, G. P. (2015). You need an innovation strategy. *Harvard Business Review, 93*, 44–54.

Price, D. P., Stoica, M., & Boncella, R. J. (2013). The relationship between innovation, knowledge, and performance in family and non-family firms: An analysis of SMEs. *Journal of Innovation and Entrepreneurship, 2*(1), 14. https://doi.org/10.1186/2192-5372-2-14

Protogerou, A., Caloghirou, Y., & Vonortas, N. S. (2017). Determinants of young firms' innovative performance: Empirical evidence from Europe. *Research Policy, 46*(7), 1312–1326. https://doi.org/10.1016/j.respol.2017.05.011

Qureshi, I., Park, D., Atilio, G., & Miguel, J. (2021). Trends and determinants of innovation in Asia and the Pacific vs. Latin America and the Caribbean. *Journal of Policy Modeling.* https://doi.org/10.1016/j.jpolmod.2020.06.008

Rahman, N. A., Yaacob, Z., & Radzi, R. M. (2016). An Overview of Technological Innovation on SME Survival: A Conceptual Paper. *Procedia - Social and Behavioral Sciences, 224*(October), 508–515. https://doi.org/10.1016/j.sbspro.2016.05.427

Romijn, H., & Albaladejo, M. (2002). Determinants of innovation capability in small electronics and software firms in southeast England. *Research Policy, 31*(7), 1053–1067. https://doi.org/10.1016/S0048-7333(01)00176-7

Razavi, S. M., Abdollahi, B., Ghasemi, R., & Shafie, H. (2012). Relationship between "innovation" and "business sophistication": A secondary analysis of countries global competitiveness. *European Journal of Scientific Research, 79*(1), 29–39.

Restrepo-Morales, J. A., Loaiza, O. L., & Vanegas, J. G. (2019). Determinants of innovation: A multivariate analysis in Colombian micro, small and medium-sized enterprises. *Journal of Economics, Finance and Administrative Science, 24*(47), 97–112. https://doi.org/10.1108/JEFAS-09-2018-0095

Roehrich, G. (2004). Consumer innovativeness - Concepts and measurements. *Journal of Business Research, 57*(6), 671–677. https://doi.org/10.1016/S0148-2963(02)00311-9

Sembiring, R. (2016). Impact of human resources' knowledge and skills on SMEs' in Medan City, Indonesia. *International Journal of Management, Economics and Social Sciences, 5*(3), 95–104.

Sharif, I., Ali, S., Hussain, S., Khalid, M., Imran, A., & Nazar, R. (2021). Dynamic common correlated effects of technological innovations and institutional performance on environmental quality: Evidence from East-Asia and Pacific countries. *Environmental Science and Policy, 124*(May), 313–323. https://doi.org/10.1016/j.envsci.2021.07.007

Smith, S. C. (1993). The competitive advantage of nations: Michael E. Porter, (Free Press, New York, 1990). *Journal of Development Economics, 40*(2), 399–404. https://doi.org/10.1016/0304-3878(93)90095-5

Statistics Solutions. (2013). *The assumption of homogeneity of variance—Statistics solutions.* Retrieved July 15, 2021, from https://www.statisticssolutions.com/the-assumption-of-homogeneity-of-variance/

Stern, S., Porter, M., & Furman, J. (2000). *The determinants of national innovative capacity.* NBER working paper no. 7876, September. The National Bureau of Economic Research.

Subramanian, A., & Nilakanta, S. (1996). Organizational innovativeness: Exploring the relationship between organizational determinants of innovation, types of innovations, and measures of organizational performance. *Omega, 24*(6), 631–647. https://doi.org/10.1016/S0305-0483(96)00031-X

Sudolska, A., & Łapińska, J. (2020). Exploring determinants of innovation capability in manufacturing companies operating in Poland. *Sustainability, 12*(17), 7101.

Szalacha-Jarmużek, J., & Pietrowicz, K. (2018). Missing causality and absent institutionalization. A case of Poland and methodological challenges for future studies of interlocking directorates. *Economics and Sociology, 11*(4), 157–172. https://doi.org/10.14254/2071-789X.2018/11-4/10

Tseng, S.-M., & Lee, P.-S. (2014). The Effect of Knowledge Management Capability and Dynamic Capability on Organizational Performance. *Journal of Enterprise Information Management, 27*, 158–179. https://doi.org/10.1108/JEIM-05-2012-0025

Tsatsenko, N., Chang, S., & Growth, E. (2020). SME development, economic growth, and structural change: SME development, economic growth, and structural change. *Journal of Agriculture and Environment.* https://doi.org/10.23649/jae.2020.2.14.7

Tsetim, J. T., Adegbe, O. B., & Agema, R. J. (2020). Knowledge management infrastructure capabilities and innovativeness of small and medium scale enterprises in Benue State, Nigeria. *Saudi Journal of Business and Management Studies, 6663*, 216–225. https://doi.org/10.36348/sjbms.2020.v05i03.006

Udimal, T. B., Jincai, Z., Ibn Musah, A.-A., & Hua, C. (2019). Determinants of new product innovation in Ghanaian SMEs sector. *Journal of Global Entrepreneurship Research, 9*(1), 1–11. https://doi.org/10.1186/s40497-018-0124-4

Ulku, H. (2004). *R&D, innovation, and economic growth: An empirical analysis.* IMF working paper no. 04/185. International Monetary Fund.

Uvarova, I., & Vitola, A. (2019). Innovation challenges and opportunities in European rural SMEs. *Public Policy and Administration, 18*(1), 152–166. https://doi.org/10.5755/j01.ppaa.18.1.23134

Vasvári, T., Danka, S., & Hauck, Z. (2019). Production and innovation—Lessons for domestic industrial policy. *Economic Review, 66*(10), 1031–1055. https://doi.org/10.18414/KSZ.2019.10.1031

Venkatraman, M. P. (1991). The impact of innovativeness and innovation type on adoption. *Journal of Retailing, 67*(1), 51–67.

Wang, C. L., & Ahmed, P. (2017). The development and validation of the organizational innovativeness construct using confirmatory factor analysis. *European Journal of Innovation Management, 7*(4), 303–313. https://doi.org/10.1108/14601060410565056

Wang, C., Kafouros, M., Yi, J., Hong, J., & Ganotakis, P. (2020a). The role of government affiliation in explaining firm innovativeness and profitability in emerging countries: Evidence from China. *Journal of World Business, 55*(3), 101047. https://doi.org/10.1016/j.jwb.2019.101047

Wang, L., Luo, G., Sari, A., & Shao, X. (2020b). Technological forecasting & social change what nurtures the fourth industrial revolution? An investigation of economic and social determinants of technological innovation in advanced economies. *Technological Forecasting & Social Change, 161*(September), 120305. https://doi.org/10.1016/j.techfore.2020.120305

Wellalage, N. H., & Fernandez, V. (2019). Innovation and SME finance: Evidence from developing countries. *International Review of Financial Analysis, 66*(July), 101370. https://doi.org/10.1016/j.irfa.2019.06.009

Wiklund, J., & Shepherd, D. (2005). Entrepreneurial orientation and small business performance: A configurational approach. *Journal of Business Venturing, 20*(1), 71–91. https://doi.org/10.1016/j.jbusvent.2004.01.001

Yachmeneva, V., & Vol's'ka, G. (2014). Factors influencing enterprise innovation. *An International Quarterly Journal, 1*(1), 133–138.

You, S., Zhou, K. Z., & Jia, L. (2021). How does human capital foster product innovation? The contingent roles of industry cluster features. *Journal of Business Research, 130*(March), 335–347. https://doi.org/10.1016/j.jbusres.2021.03.046

Zanello, G., Fu, X., Mohnen, P., & Ventresca, M. (2016). The creation and diffusion of innovation in developing countries: A systematic literature review. *Journal of Economic Surveys, 30*(5), 884–912. https://doi.org/10.1111/joes.12126

Zawawi, N. F. M., Mamun, A. A., Wahab, S. A., Yaacob, A. S., Kumar, N., & Fazal, S. A. (2016). Defining the concept of innovation and firm innovativeness: A critical analysis from resource-based view perspective defining the concept of innovation and firm innovativeness: A critical analysis from resource-based view perspective. *International Journal of Business and Management, 11*(6), 1–87. https://doi.org/10.5539/ijbm.v11n6p87

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