



# Engineering Journal IJOER

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## Preface

We would like to present, with great pleasure, the inaugural volume-11, Issue-8, August 2025, of a scholarly journal, *International Journal of Engineering Research & Science*. This journal is part of the AD Publications series *in the field of Engineering, Mathematics, Physics, Chemistry and science Research Development*, and is devoted to the gamut of Engineering and Science issues, from theoretical aspects to application-dependent studies and the validation of emerging technologies.

This journal was envisioned and founded to represent the growing needs of Engineering and Science as an emerging and increasingly vital field, now widely recognized as an integral part of scientific and technical investigations. Its mission is to become a voice of the Engineering and Science community, addressing researchers and practitioners in below areas:

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Neural Networks	Plastic Engineering

Each article in this issue provides an example of a concrete industrial application or a case study of the presented methodology to amplify the impact of the contribution. We are very thankful to everybody within that community who supported the idea of creating a new Research with IJOER. We are certain that this issue will be followed by many others, reporting new developments in the Engineering and Science field. This issue would not have been possible without the great support of the Reviewer, Editorial Board members and also with our Advisory Board Members, and we would like to express our sincere thanks to all of them. We would also like to express our gratitude to the editorial staff of AD Publications, who supported us at every stage of the project. It is our hope that this fine collection of articles will be a valuable resource for *IJOER* readers and will stimulate further research into the vibrant area of Engineering and Science Research.



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# Development of a 24/7 Odor Gas Analyzer System for Spoiled Products in Cryogenic Warehouses and Its Market Potential in Europe and Asia

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**Abstract**— *The quality of freezing is primarily checked by the operating parameters of the cryogenic equipment itself: power losses during operation, freon leaks, etc. However, the end user is interested in whether the product will spoil in the freezer or in the warehouse or not. This work is devoted to the creation of thermodynamic gas analyzers for the smell of spoiled frozen products and their 24/7 monitoring on the company's website and an assessment of their implementation in the European and Asian markets.*

**Keywords**— *Thermodynamic Gas Analyzers, Smell Detection, Spoiled Frozen Products, 24/7 Monitoring, Food Safety Sensors, Cryogenic Equipment.*

## I. INTRODUCTION

In the European Union, special attention is paid to the transition of cryogenic equipment to less aggressive coolants and a complete ban on their use by 2050 by manufacturers of cryogenic equipment. In this regard, it is interesting to know how these methods affect the final result and whether frozen products spoil in supermarkets and food cryogenic warehouses, in automobile, rail, river and sea cryogenic transport. [1,2]

## II. PROBLEM FORMULATION

Thermodynamic food smell gas analyzers are designed to determine the spoilage of frozen products in cryogenic chambers installed outside the cryogenic equipment. Usually, the quality of the product is measured by the presence of gases of decay of various food products. Rotting and spoilage of meat products is ammonia, carbon dioxide, methane, hydrogen sulfide. Dairy products are carbon dioxide, methane and hydrogen sulfide, etc. In other words, if you have the appropriate gas analyzers for these gases or have all 4 or 3 gases in this gas analyzer (calibration curves, for example, a gas analyzer for hydrogen sulfide, but also contains curves, for example, carbon dioxide, ammonia and methane), then depending on the different degrees of decay, and this is the corresponding number, the value of this gas in ppm, then you can program this data into the memory of the microcontroller. Upon reaching certain parameters, the sensor: gas analyzer with a microcontroller will give and show not only the values of rotting gases but also the degree of rotting.

However, many gases have odors: methane, hydrogen sulfide, ammonia, organic rotting has a smell. The smell is a more subtle substance than the presence of some gas in the air. This increases the accuracy of rotting detection, even behind the wall of cryogenic equipment. As experiments have shown, an insignificant content of the smell of rotting, seeping through the freezer is enough to identify rotting by the smell of the product inside the chamber. In order to determine the smell of rotting frozen products inside the cryogenic chamber, a second calibration was made by the smell of rotting.[3,4]

The first calibration is factory by gas type. Calibration was carried out for a given gas analyzer and for a given gas depending on the strength of the unpleasant smell of rotting. Conventionally weak, weak average, strong weak, strong, unbearable. The

obtained data for each gas were stored in the microcontroller memory and depending on the type of product. For example, frozen fish, pizza with meat.

The odor measurement system is a nonequilibrium thermodynamic system [5,6] and at any moment it depends on various factors, the strength of decay, the impact of other gases involved in the decay process, temperature, humidity both in the room and in the chamber, etc., that is, the functionality of the decay process of various parameters. Their changes show the odor's intensity for each concentration, each incoming gas and for 2 functional or their sub functional have the form:

$$P_1 = f_1(E_1, E_2)$$

$$P_2 = f_2(E_1, E_2)$$

Differentiating among the equation, absolutely the outcome will be:

$$dP_1 = A_{11} dE_1 + A_{12} dE_2$$

$$dP_2 = A_{21} dE_1 + A_{22} dE_2$$

There are simple and cross-sectional coefficients of connections between singles structures of state and interactions of structures under distribution of arrays of odor's rotting concentration data under depending on the change and increase in freezing temperature, the time periods of these changes, humidity and other reasons. Basic and cross coefficients A in the form of corresponding functions of various functionals E:

$$A_{11} = f_{11}(E_1, E_2)$$

$$A_{12} = f_{12}(E_1, E_2)$$

$$A_{21} = f_{21}(E_1, E_2)$$

$$A_{22} = f_{22}(E_1, E_2)$$

That is, the refined data array is calculated using the equations of a nonequilibrium thermodynamic system and stored in the microcontroller's memory.

Thermodynamic food odor analyzers are combined into a system for measuring odors of volumes or measured points of a refrigerated warehouse with registration of concentrations of odors of rotting frozen products on the website of the company that owns the cryogenic equipment in 24/7 mode constantly.

The prospects for the implementation of a system for monitoring thermodynamic gas analyzers based on the smell of food for cryogenic equipment for frozen products in supermarkets are as follows.

## 2.1 Analysis of the efficiency of using thermodynamic food odor gas analyzers in the European and Asian markets:

### 2.1.1 European Market:

#### Competitors and Analogues:

#### Gas analyzers for Modified Atmosphere Packaging (MAP) control:

- Cambridge Sensotec (Rapidox 1100Z, Oxybaby) – analysis of O<sub>2</sub>, CO<sub>2</sub>, humidity.
- DynaSNACK – leak detection in packaging.

#### Odor sensors:

- Aryballe Technologies (universal sensors for the food industry).
- Figaro Engineering (gas sensors for quality control).

#### Prices and Sales Volume:

- The European gas analyzer market was valued at approximately \$766.7 million in 2023, with a CAGR of 5.9%.
- Odor sensor segment is growing faster, with a CAGR of 29.4%, forecasted to reach \$19.4 billion by 2031.

- Price examples: portable MAP analyzers range from \$2,000 to \$5,000; stationary systems can cost up to \$20,000.

**Buyers:**

- Food manufacturers (freshness control, compliance with EU standards).
- Logistics companies (monitoring storage conditions).
- Quality control and certification laboratories.

**2.1.2 Asian Market:****Competitors:**

- **Chinese manufacturers:** Beijing Zetron (smoke gas analyzers), Beijing HiYi Technology (portable detectors).
- **Japanese brands:** Figaro Engineering, Panasonic (sensors for smart homes and food industry).

**Trends:**

- The gas analyzer market is growing due to stricter environmental regulations and demand for “smart” agriculture.
- In China and India, there is a strong focus on combating food fraud and ensuring safety.

**Prices:**

- Budget Chinese analyzers start from around \$500; industrial-grade solutions range from \$3,000 to \$10,000.

**Buyers:**

- Large agricultural holdings.
- Seafood and meat processing factories.
- Premium retail supermarkets.

**2.2 Product Uniqueness and Recommendations****Advantages:**

- Miniature size (matchbox-sized modification) – an advantage for field inspections.
- Linking odors with basic tastes – potential for standardization in R&D and quality control.

**Risks:**

- Strong competition from MAP analyzers and multi-gas systems.
- Need for certification according to ISO, CE, FDA standards to enter European and Asian markets.

**Go-to-Market Strategy:**

Focus on niche segments: premium products (coffee, chocolate, cheeses) where flavor and aroma profiles are critical.

Partnerships with quality laboratories and universities (e.g., for research on taste compatibility).

Pricing strategy: \$1,500–\$3,000 for the portable version; \$8,000–\$12,000 for the stationary unit (positioned below premium competitors).

**2.3 Review of Competitors and Analogues in the European and Asian Gas Analyzer Markets****2.3.1 European Market:****Key Players and Products:**

**ABB Ltd, Honeywell International Inc., Emerson Electric Co., Siemens AG, Thermo Fisher Scientific** are leading manufacturers of gas analyzers, offering a wide range of stationary and portable devices.

Products include gas chromatographs, electrochemical, paramagnetic, and infrared analyzers used in the food industry, oil and gas sector, pharmaceuticals, and environmental monitoring.

**Examples:**

- **Emerson Rosemount** - stationary analyzers for emission and product quality control.

- **Cambridge Sensotec Rapidox** - portable O<sub>2</sub> and CO<sub>2</sub> analyzers popular in the food industry.

### Prices and Trends:

#### Average Price Range:

- Portable devices - \$2,000–\$5,000
- Stationary systems - \$10,000–\$20,000 and higher

The gas analyzer market in Europe is growing at a CAGR of around 5.9% (2024–2029), driven by tightening environmental and food safety standards.

Trend towards integration with digital platforms and IoT for remote monitoring and analytics.

Prices for basic models remain stable, but premium systems with extended functionality and automation are gradually becoming more expensive.

### Market Segments and Changes

- **Food Industry** - a growing segment due to requirements for quality control and food safety.
- **Environmental Monitoring and Emission Control** - a key driver of demand, especially in the EU with new sustainable development regulations.
- **Oil and Gas Sector** - steady demand for analyzers to control processes and ensure safety.

Implementation of new EU regulations (e.g., PPWR) is stimulating demand for innovative solutions for packaging and product quality control.

### 2.3.2 Asian Market:

#### Key Players and Products

- Chinese companies, such as **Beijing Zetron** and **Beijing HiYi Technology**, offer budget-friendly and industrial gas analyzers, including portable models for quality control.
- Japanese brands **Figaro Engineering** and **Panasonic** are known for their sensors for the food industry and household applications.
- Growing interest in "smart" sensor solutions integrated into smart agriculture and product safety control systems.

### Prices and Trends

Price Range:

- Budget Chinese analyzers - from \$500 to \$2,000
- Industrial solutions - \$3,000–\$10,000

The gas analyzer market in the Asia-Pacific region demonstrates the highest CAGR globally (above 6% in 2024–2029), driven by manufacturing growth and stricter safety standards.

Prices for basic models are declining due to local production and scaling, while complex systems with high precision and automation are becoming more expensive.

Increased quality control and combating product counterfeiting are stimulating demand for innovative gas analyzers.

### Market Segments and Changes:

- **Agro-Industrial Complex and Food Processing** - the main driver of growth, especially in China and India.
- **Premium Retail** - a growing segment requiring monitoring of freshness and taste qualities.
- **Environmental and Industrial Monitoring** - developing in parallel with industrial production growth and environmental requirements.

**TABLE 1**  
**MARKET SEGMENTS AND CHANGES**

Parameter	Europe	Asia
Key Players	ABB, Honeywell, Emerson, Siemens	Beijing Zetron, Figaro, Panasonic
Price Range	\$2,000–\$20,000	\$500–\$10,000
Market Growth Rate	CAGR ~5.9%	CAGR >6%
Price Trends	Stable basic, premium growth	Decline in budget, premium growth
Key Segments	Food industry, environmental monitoring	Agro-industry, retail, environmental monitoring
Technological Trends	IoT, digitalization, automation	Localization, smart sensors

If your product – a compact, digital gas analyzer with a unique feature for measuring odors and linking them to taste profiles – it can carve out a niche in the premium segment of the food industry and laboratory control, especially in Europe and the Asia-Pacific region.

For successful market entry, it is important to consider certification requirements, integration with digital systems, and partnerships with laboratories and food manufacturers.

### III. COMPARATIVE ANALYSIS

Here is the detailed comparative analysis of prices, brands, and models of gas analyzers for the food and related industries in European and Asian markets in table format:

**TABLE 2**  
**COMPARATIVE ANALYSIS OF PRICES, BRANDS, AND MODELS OF GAS ANALYZERS**

Region	Brand / Model	Device Type	Key Features	Price Range (USD)	Price & Market Trends	Key Market Segments
Europe	Cambridge Sensotec Rapidox 1100Z	Portable Gas Analyzer	O <sub>2</sub> , CO <sub>2</sub> , humidity analysis, accuracy ±0.1 ppm	\$2,000 – \$5,000	Prices stable; growing demand for IoT and digitalization	Food industry, labs, logistics
	Emerson Rosemount 700XA	Stationary Analyzer	High-precision emissions and air quality analysis	\$10,000 – \$20,000+	Premium systems prices rising with automation	Environment, oil & gas, industry
	Figaro Engineering (Sensors)	Odor Sensors	Universal gas sensors for odor control	\$1,500 – \$4,000	Stable prices; increasing adoption in food sector	Food industry, consumer devices
	Aryballe Technologies	Sensor Devices	Optical odor sensors with digital processing	\$3,000 – \$8,000	Prices rising with tech development; sensor market growth	Food industry, R&D
Asia	Beijing Zetron Portable Analyzer	Portable Gas Analyzer	Budget models for quality control	\$500 – \$2,000	Prices decreasing due to local manufacturing	Agro-industry, food processing
	Beijing HiYi Technology	Industrial Analyzers	Compact and stationary models	\$3,000 – \$10,000	Complex systems prices rising; basic models decreasing	Agro-industry, industry, retail
	Figaro Engineering (Japan)	Gas Sensors	High-precision sensors for food and consumer use	\$1,500 – \$4,500	Stable prices; gradual growth	Food industry, consumer devices
	Panasonic Gas Sensors	Sensors and Modules	Integration into smart systems, consumer & industrial	\$1,000 – \$5,000	Growing demand for smart solutions; moderate price growth	Smart homes, food industry

### 3.1 Comparative Analysis. Detailed comparative analysis of prices, brands, and models of gas analyzers:

For the food industry and related sectors in European and Asian markets. **Price and Market Trends**

#### Europe:

- Prices for basic portable analyzers remain stable, around \$2,000–\$5,000.
- Premium stationary systems are becoming more expensive due to IoT integration and automation (up to \$20,000+).
- Increasing demand for digital and networked solutions for remote monitoring.
- The food industry and environmental monitoring are the main growth drivers.

#### Asia:

- Budget Chinese portable models are reducing prices in the \$500–\$2,000 segment.
- Complex industrial systems have become more expensive due to the implementation of new standards and technologies (\$3,000–\$10,000).
- The smart sensor system segment is growing, especially in Japan and South Korea.
- Main demand is from agro-industrial complexes, food processing, and premium retail.

### 3.2 Market Segments and Their Dynamics

#### Food Industry

- Europe: Growth due to quality control and safety requirements
- Asia: Rapid growth, especially in processing and agro-industrial sectors

#### Environmental Monitoring

- Europe: Key segment supported by the EU
- Asia: Growing segment, driven by industry and urban development

#### Oil & Gas and General Industry

- Europe: Stable demand
- Asia: Growth in industrial sectors, especially in China and India

#### Premium-Class Retail

- Europe: Moderate growth, focus on quality
- Asia: Rapidly growing, especially in large cities

The new gas analyzer model with integrated odor detection offers strong profitability potential due to its niche positioning in the premium segment. Unlike standard analyzers, it combines precise leak detection with AI-powered spoilage monitoring — a unique feature highly valued in food safety, logistics, and retail. With growing regulatory pressure in the EU and Asia to improve refrigeration efficiency and environmental standards, demand is expected to rise.

The model's compact format, IoT compatibility, and modular design make it suitable for both high-end supermarkets and industrial applications. These factors ensure long-term market relevance and justify premium pricing.

**TABLE 3**  
**COMPARATIVE TABLE OF GAS ANALYZERS BY REGION**

Region	Brand / Model	Device Type	Key Features	Price Range (USD)	Price & Market Trends	Key Market Segments
Europe	<b>Cambridge Sensotec Rapidox 1100Z</b>	Portable gas analyzer	O <sub>2</sub> , CO <sub>2</sub> , humidity analysis, accuracy ±0.1 ppm	\$2,000 – \$5,000	Stable prices, growing demand for IoT and digitalization	Food industry, laboratories, logistics
	<b>Emerson Rosemount 700XA</b>	Stationary analyzer	High-precision emissions and air quality analysis	\$10,000 – \$20,000+	Rising prices for premium systems with automation	Environmental monitoring, oil & gas, industry
	<b>Figaro Engineering (sensors)</b>	Odor sensors	Universal gas sensors for odor control	\$1,500 – \$4,000	Stable prices, increased use in food sector	Food industry, household appliances
	<b>Aryballe Technologies</b>	Sensory devices	Optical odor sensors, digital processing	\$3,000 – \$8,000	Prices rising with tech advances, sensor market growth	Food industry, R&D
Asia	<b>Beijing Zetron Portable Analyzer</b>	Portable gas analyzer	Budget models for quality control	\$500 – \$2,000	Decreasing prices due to local production	Agro-industry, food processing
	<b>Beijing HiYi Technology</b>	Industrial analyzers	Compact and stationary models	\$3,000 – \$10,000	Price increase for complex systems, basic models decreasing	Agro-industry, industry, retail
	<b>Figaro Engineering (Japan)</b>	Gas sensors	High-precision sensors for food and home sectors	\$1,500 – \$4,500	Stable prices, gradual increase	Food industry, household appliances
	<b>Panasonic Gas Sensors</b>	Sensors and modules	Integration into smart systems, home and industrial use	\$1,000 – \$5,000	Demand for smart solutions rising, moderate price growth	Smart home, food industry

#### IV. CONCLUSION

- Fundamentally new thermodynamic gas analyzers for the smell of food with a second calibration for the smell of decay have been developed based on the equations of a nonequilibrium thermodynamic measurement system for cryogenic equipment with the installation of gas analyzers outside the chamber in 24/7 monitoring mode on the website of the company that owns the cryogenic equipment.
- The European market is characterized by stable prices for basic models and rising costs for premium systems with IoT integration.
- The Asian market offers more budget-friendly solutions, but rising demand for high-precision and smart systems is increasing prices for complex models.
- This product, with a miniature digital gas analyzer and a unique odor detection feature, can occupy a niche in the premium food industry and laboratory monitoring segment — especially in Europe and Asia.
- The comparative table highlights key differences in gas analyzer offerings across European and Asian markets. European brands focus on high-precision, IoT-integrated systems with stable prices for portable models and rising costs for premium stationary solutions. In contrast, Asian manufacturers provide more affordable options, especially for entry-level and mid-range analyzers, while also expanding smart sensor technologies.

6. Market demand in both regions is driven by food safety, environmental monitoring, and industrial applications. Europe emphasizes quality and regulation, while Asia shows rapid growth in cost-sensitive and smart device segments. These trends present strategic opportunities for niche, innovative solutions.

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# To Empirically Study the Link between Entrepreneurship, Innovation and Economic Growth

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**Abstract**— *Entrepreneurship is a crucial component of a flourishing economy, driving innovation, Schumpeterian rivalry, and overall economic vitality. Using GEM data and a three-stage least squares (3SLS) model, this research looks at the relationship between entrepreneurial activity and GDP growth in 125 industrialized and developing countries. This study attempts to put a number on expansion, creativity, and initiative by using a Cobb-Douglas production function specification in conjunction with the Static Panel Data Method and the Generalized Method of Moments (GMM). Although the results imply that innovation and entrepreneurship may not significantly impact development in developing nations, the positive and statistically significant relationship between the two groups of countries more than compensates for any short-term setbacks.*

**Keywords**— *Industrialized, Countries Entrepreneurship, Innovation and Economic Growth.*

## I. INTRODUCTION

An essential component of a flourishing economy is entrepreneurship, or the act of launching and managing one's own firm. One of the most important components of dynamic Schumpeterian competition and economic dynamism is the role that entrepreneurs play in fostering innovation. Inventive business owners are the driving forces behind the perpetual Schumpeter cycle of new goods and services displacing older ones throughout all sectors of the economy. There are a lot of young firms on Fortune 100 that are making and selling innovative items using cutting-edge innovation. The Fortune 100 of 1970 would look completely different from the Fortune 100 of today by the year 2070. Steve Jobs, who co-founded Apple with pals in his suburban California garage, is just one example of the kind of visionary, game-changing, risk-taking entrepreneur that is constantly giving rise to new firms with innovative goods and technology.

Every business, no matter how little, is under pressure to innovate in today's market. This is true even for street food sellers. Therefore, entrepreneurs that don't have a transformative mindset nonetheless contribute to the economy. Entrepreneurs have been understudied and undervalued for a long time, despite the fact that they are crucial to new product development and overall economic expansion. One reason for this is the paucity of data available prior to the creation of databases like the Global Entrepreneurship Monitor (GEM) in recent years. It is intrinsically difficult to quantify entrepreneurship and the variables that lead entrepreneurs to become entrepreneurs, and this lack of study and recognition reflects this. Also, most new enterprises fail, so it's hard to describe entrepreneurship as a reasonable undertaking. So, unreasonable optimism or euphoria is necessary to become an entrepreneur. The immense variety of entrepreneurial endeavors may also explain why economists have historically paid little attention to this field.

It is difficult to accurately define entrepreneurship since entrepreneurs vary from people selling street food to revolutionary thinkers like Elon Musk. There are many entrepreneurs who make a lot of money, but there are a few that really shake things up and have a huge impact on innovation, productivity growth, and economic vitality. Despite the minimal likelihood of success, transformational entrepreneurs are often the first to take risks and grab undiscovered chances. Innovative entrepreneurs with a bold vision for the future build whole new markets, goods, and services by reimagining existing problems. For example, back when most people only watched the news in the evenings, Ted Turner launched a cable TV network that aired news all day, every day. Still, in the intervening forty years, news networks that air nonstop have grown ubiquitous.

## II. LITERATURE REVIEW

**Divya, Dr et.al. (2024).** Economic Growth in India: How Entrepreneurship Has Contributed, Statistically Speaking. An entrepreneur's ability to spark expansion and improvement in the economy is widely acknowledged, particularly in developing nations such as India. Using primary data gathered from several states, this research investigates how entrepreneurial activities have affected India's economic development. The research looks at how innovation, employment rates, and GDP growth are related to entrepreneurialism. In addition to recommending policies to encourage an entrepreneurial environment, the results show how entrepreneurs have greatly benefited India's economy.

**Ilahi, Saud et.al. (2020).** In order to spur economic progress, entrepreneurialism is seen as crucial. Not only does it boost output and GDP, but it also encourages new ideas, more jobs, higher wages, and better living conditions for all citizens. The influence of entrepreneurs on global economic development varies among countries, contrary to popular belief. Concerning Impact of Entrepreneurship on Gross Domestic Product Growth in Developed and Poor Countries nations, academics have reached conflicting conclusions. Researchers have also speculated that other variables, such as GDP growth is affected by a nation's level of economic development. To find out, we set out to study the relationship between entrepreneurialism and GDP growth in the country. There has been an attempt to ascertain how entrepreneurialism affects economic development by reviewing the existing research.

**Sedeh, Amirmahmood et.al. (2022).** As a matter of paramount importance to policymakers, innovative entrepreneurship is a critical component of progress in the economy, particularly in countries that are less developed. On the other hand, developing countries' literature on innovative entrepreneurship is lacking and rising nations, specifically on the ways in which several variables interact at different levels. To solve this problem, we created a multi-level model that shows how entrepreneurial talents mitigate the effect of obstacles to innovation. Our research on a cross-section of The data from 24 countries (17 developing and 7 emerging) reveals that creative entrepreneurship is driven by entrepreneurial abilities to overcome innovation challenges, both on the supply and demand sides and in the broader innovation environment. The results provide valuable information for entrepreneurs, investors, and governments in developing nations who are looking to foster creative entrepreneurship.

**Katjiteo, Ancia. (2024).** This chapter explores the interdependent essence of entrepreneurialism and innovation, examining their interplay to boost the economy and improve people's lives. Innovation is propelled from the genesis of new ideas to their commercial realisation by entrepreneurial endeavours, which are defined by the pursuit and capitalisation of possibilities. Entrepreneurial efforts foster an innovation-friendly environment, which in turn spurs disruptive technologies, business models, and social activities. This chapter explains this via case studies and theoretical frameworks.

**Ivanović-Đukić, Maja et.al. (2022).** The significance of entrepreneurial endeavors in promoting sustainable progress and expansion in developing economies both before and after the COVID-19 epidemic is explored in this article. The significance of different actions taken by governments and enterprises in light of the changing COVID-19 epidemic environment is also discussed. Using data from 20 developing economies, the researchers found that economic development pre-pandemic levels of HEA were favorably connected with this variable, but during the COVID-19 crisis, this connection became negative. The research also showed that the right responses to the COVID-19 epidemic may be a powerful instrument for reviving the economy and encouraging the rise of entrepreneurs in the aftermath of the virus in developing nations.

## III. ENTREPRENEURSHIP

When people take the initiative to start their own businesses, it boosts the economy nationwide and in individual communities. The capacity of people to recognise and capitalise on business possibilities is fundamental to entrepreneurship, which in turn drives the robust expansion of our economies. Entrepreneurship is a powerful force for innovation, job creation, and market competitiveness due to its transformational and ever-changing character. Those that are up for the challenge of starting a new company are the ones who ultimately succeed.

Numerous forms of entrepreneurship exist. Here are a few examples: Innovations in food production, housing, energy, and transportation are some of the societal problems that social entrepreneurs seek to address. Entrepreneurs with a social mission often form organisations and focus their businesses on improving society. With the goal of quick growth, scalable entrepreneurs seek for unmet needs in the market and provide solutions. A scalable entrepreneurial endeavour is Uber.

A key component of innovation entrepreneurship involves coming up with new concepts, procedures, or goods, or the improvement of existing ones to meet consumer demands. The innovation environment is undergoing a significant shift as a result of startups like Omni Sync creating and deploying groundbreaking technology. As part of our Turbos BIR offering,

Omni Sync has been assisting other entrepreneurs, small companies, and startups in their pursuit of grant funding. This financing will enable them to further their own creative ideas.

### **3.1 Innovation:**

Modernizing an old process, product, or service by incorporating fresh ideas, methods, or technology into it is what we call innovation. Competitive marketplaces are propelled by innovation. Adding value to an existing idea, product, or method is the hallmark of innovation. The invention of the wheel in the fourth millennium BC, virtual reality, energy-producing roadways, autonomous vehicles, and many more instances abound.

### **3.2 Entrepreneurship and Innovation in Emerging Markets:**

Especially in emerging markets, progress and expansion in the economy, are driven by entrepreneurialism and innovation. Entrepreneurs in developing nations have been using innovation to build new companies, goods, and services that have boosted local economies and made millions of people's lives better in the last several years. This article will discuss the possibilities and threats that entrepreneurs confront in developing markets, as well as the connection between innovation as well as entering these fields as entrepreneurs.

### **3.3 Emerging Markets as a Site for Entrepreneurship and Innovation Markets:**

Quickly expanding consumer markets, increasing incomes, and booming economies are the hallmarks of emerging markets. Entrepreneurship and innovation flourish in this setting because of these elements. Startups in developing economies may meet the wants and requirements of customers there by developing innovative goods and services. In developing economies, there are many promising new avenues for business creation and technological advancement, including:

#### **3.3.1 Access to New Markets:**

New and expanding consumer markets are accessible to entrepreneurs in emerging countries. Opportunities for entrepreneurs abound in developing nations, thanks to growing middle classes and disposable incomes, where they may start new companies and provide customers with cutting-edge goods and services.

#### **3.3.2 Low Competition:**

Low levels of competition are typical in many developing markets, especially in the consumer goods and technology industries. This is a great chance for ambitious businesspeople to get into these areas and become market leaders.

#### **3.3.3 Low Cost of Labor and Resources:**

The development and launch of new firms might be cheaper for entrepreneurs in emerging countries due to the reduced prices of labour and resources. This may be especially helpful for startups that are trying to make do with little capital and resources.

#### **3.3.4 Problems That New Market Entrepreneurs Must Overcome:**

While many opportunities for innovation and entrepreneurship exist in developing nations, entrepreneurs also confront several challenges. Companies operating in emerging areas have several challenges, the most significant of which are:

#### **3.3.5 Limited Access to Capital:**

The lack of readily available funding business owners in emerging markets have a significant challenge. Traditional finance sources, like banks and venture capitalists, may be difficult for many entrepreneurs to access, which can hinder their capacity to expand and develop their company.

#### **3.3.6 Lack of Infrastructure:**

In order to foster entrepreneurial activity, emerging economies sometimes do not have the required infrastructure, such consistent access to energy and the internet. Because of this, it may be challenging for entrepreneurs to run their companies efficiently and successfully.

#### **3.3.7 Political and Economic Instability:**

Political and economic volatility are common features of emerging economies, making them difficult places for entrepreneurs to operate in. Business owners may find it challenging to invest in their companies for the long haul due to this uncertainty.

### **3.3.8 Cultural and Language Barriers:**

Building ties with local clients and associates may be difficult for business owners operating in underdeveloped nations due to linguistic and cultural obstacles. If they want to be successful in these markets, businesses need to know how to deal with cultural and language difficulties.

### **3.4 Strategies for Success in Entrepreneurship and Innovation in Emerging Markets:**

Even with all these obstacles, there are still plenty of ways for entrepreneurs to thrive in developing markets via innovation and entrepreneurship. Among the most important approaches are:

#### **3.4.1 Building Strong Networks:**

To thrive in developing countries, you must network and connect with local partners, consumers, and investors. In order to gain credibility and trust, entrepreneurs need invest effort into developing strong connections with influential people in their fields.

#### **3.4.2 Developing Innovative Products and Services:**

Being successful in new markets requires constant innovation. Entrepreneurs should prioritise creating new products and services that meet the unique needs and preferences of regional customers.

#### **3.4.3 Embracing Technology:**

Entrepreneurs in developing economies may greatly benefit from technological advancements. In order to grow their companies, attract more consumers, and work more efficiently, entrepreneurs need use technology.

#### **3.4.4 Fostering a Culture of Collaboration:**

Achieving success in new markets requires close collaboration. In order to develop a solid support system and exchange information and resources, entrepreneurs should reach out to local suppliers, partners, and other stakeholders for collaboration.

#### **3.4.5 Developing a Strong Business Plan:**

When venturing into new markets, a solid business strategy is crucial. A thorough business plan including objectives, methods, and financial estimates should be meticulously crafted by entrepreneurs.

#### **3.4.6 Seeking Out Alternative Funding Sources:**

There may be a lack of access to conventional financing in many developing economies. Microfinance, crowdsourcing, and impact investment are alternate financing sources that entrepreneurs should look into if they want to have the money to expand their company.

#### **3.4.7 Adapting to Local Markets:**

The ability to adjust to local markets and meet the demands and tastes of customers is crucial for businesses in developing countries who want to succeed. To achieve this goal, it may be necessary to tailor offerings to specific geographic areas, or to create advertising campaigns that appeal to local tastes.

### **3.5 The Role of Institutions, Entrepreneurship, and Growth in the Economy:**

Entrepreneurs, academics, politicians, and development agencies all face exciting challenges and opportunities at the crossroads of entrepreneurship and economic growth (Naudé Citation2011; Ramaano Citation2021). Yet, few economics academics having access to data from studies that examine the impact of entrepreneurs on economic growth (e.g., Leibenstein Citation1968; Schumpeter Citation1942). Entrepreneurs are essential to economic progress because they facilitate the process of creative destruction by bringing novel goods and services to consumers and sellers The sources cited are from Awad, Al-Jerashi, and Alabaddi (2021) and Schumpeter (1942).

Recent studies (e.g., Citations (Acs, Autio, and Szerb 2014a, 2014b; Aparicio, Turro, and Noguera 2020) have rekindled interest in the contribution of entrepreneurs to GDP growth, expanding upon earlier discussions in this area. Regarding this matter, according to Naudé (Citation2011, 3), "Interest was reignited by the improved availability of relevant cross-country data, by the resurgence of entrepreneurship after the fall of communism and by the gradual reforms initiated by China since the late 1970s, by the emerging recognition of the role of institutions in both fields, and by the increasing emphasis on private sector development by donors and international development agencies."

According to several studies (Acs, Desai, and Hessels Citation2008; Acs, Szerb, and Citations from Autio (2016) and Baumol, Litan, and Schramm (2007) entrepreneurs can increase economic activity, which in turn creates more jobs and income for more people, thus "growing the pie" (Citation2007). Acs, Szerb, and Autio (2016) note that there is a The entrepreneurial literature is ambiguous when it comes to determining the exact relationship between and human welfare and global prosperity.

To this day, our knowledge of the importance of institutions in fostering entrepreneurial spirit and driving economic expansion relies heavily on the ground-breaking research of Douglass North (Citation1990, Citation2005) and Baumol (Citation1990). Entrepreneurs, according to this view, may make significant contributions to the well-being economic growth in line with a society's established norms and practices (Baumol Citation1990; Baumol and Strom Citation2007; Sobel Citation2008). Institutions, which may be described as the "rules of the game in a society," have a crucial role in fostering or limiting entrepreneurial endeavours that contribute to economic progress and prosperity (Baumol Citation1990; North Citation1990). Also, according to North (Citation1990), both official (formal, like rules and regulations) and informal, like social mores and customs institutions are the primary sources of these incentives, both good and negative.

More specifically, North cites formal institutions as existing to lessen the transaction costs brought about by laws, and Citation2005, cites informal institutions as aiming to lessen the uncertainties associated with human contact. The results of the multi-level. The encouragement of more "productive" entrepreneurial endeavors is significantly impacted by interactions between official and informal institutions (Aparicio, Turro, and Noguera Citation2020; Baumol Citation1990; North Citation1990). Hence, the theory of institutions may aid in understanding the elements that promote entrepreneurial activity, leading to economic growth in rapidly expanding economies, as stated by Bjørnskov and Foss (2013), Bruton, Ahlstrom, and Li (2010), Sisaye (2021), Veciana and Urbano (2008), and Hasan and Hassan (2021).

As far as economic growth, institutional development, and knowledge production are concerned, the Czech Republic, Slovenia, and Estonia are among the few developing economies that have seen such a tremendous transition. There has been less success in boosting economic development in the Kyrgyz Republic, Ghana, and Georgia when compared to other emerging countries. Knowing how institutional factors affect entrepreneurial endeavors is crucial in the context of emerging economies. The best way for developing countries in the efficiency-and factor-driven phases to diversify their economies, increase exports, and move into the innovation-driven stage is a question that some scholars are beginning to ask, where they can become knowledge-based.

Entrepreneurs in developing nations are better able to distribute scarce resources than central governments, and the market must constantly adapt to new circumstances by adjusting the "separate actions of different people" and "the conditions of supply of various factors of production"(Amorós and Acs) Citation2008, 310). That's why entrepreneurship is important for these economies. In addition, some nations have improved their policies for small and medium enterprises, private sector growth, and institutional framework in acknowledgment of the importance of the markets where entrepreneurs participate. As a result, developing nations who are just entering the innovation phase must provide the right circumstances for more "productive" entrepreneurship to flourish, hence boosting their economy.



**FIGURE 1: The Importance of Entrepreneurship for Economic Growth**

*Source: Freepik.com*

Nine key points may be drawn from entrepreneurship's role in propelling economic expansion:

### **3.5.1 Raises Standard of Living:**

Entrepreneurial endeavors greatly augment monetary expansion via, among other things, the launch of new businesses, the generation of capital, and the provision of more employment opportunities and, by extension, in order to raise living standards for everybody. Businesses not only provide jobs and revenue, but entrepreneurs also have the power to make people's lives better by creating goods and services that are accessible, safe, and useful. Essential goods are no longer scarce because to the launch of new services and goods made possible by entrepreneurial spirit.

### **3.5.2 Economic Independence:**

Through entrepreneurship, both the country and the entrepreneur have the potential to attain economic autonomy. It promotes manufacturing at home and reduces reliance on foreign suppliers. Expansion, self-sufficiency, monetary inflow, and economic autonomy may all result via the sale of goods and services to international markets. In a similar vein, entrepreneurs have total say over their own monetary destiny. They are able to attain economic independence and financial stability as a result of the revenue and riches they make through their hard work and ingenuity.

### **3.5.3 Benefits of New Firms and Businesses:**

If done well, entrepreneurship may help a nation and its citizens achieve financial autonomy. The country becomes less reliant on foreign products and services, and more capable of providing for itself. Exporting the produced products and services to other countries may also bring to growth, autonomy, financial gain, and economic autonomy. And just like that, businesses get to decide how their money will be spent. They are able to attain economic independence and financial stability by their innovative thinking and hard labour, which generates revenue and riches.

### **3.5.4 Creation of Jobs:**

The development of new jobs is greatly influenced by entrepreneurialism. Opportunities for employment expand as a consequence of managing the day-to-day operations of new companies and satisfying client needs. New employment opportunities are generated across many different industries, including manufacturing, construction, services, and technology, as a result of entrepreneurial activity, which in turn stimulates innovation, competition, and investment.

### **3.5.5 Encourages Capital Formation:**

In order to sustain economic development and new company endeavours, Savings and investments are forms of capital that may be amassed. In order to encourage the development of capital, businesses may try to entice investors. By starting new businesses and growing existing ones, we can create a more diverse and dynamic economy that encourages capital creation and offers a plethora of investment opportunities.

### **3.5.6 Elimination of Poverty:**

In order to sustain economic development and new company endeavours, Savings and investments are forms of capital that may be amassed. In order to encourage the development of capital, businesses may try to entice investors. By starting new businesses and growing existing ones, we can create a more diverse and dynamic economy that encourages capital creation and offers a plethora of investment opportunities.

### **3.5.7 Community Development:**

An entrepreneurial mindset improves people's quality of life by stimulating the economy, expanding consumers' access to goods and services, and lowering prices for everyone. Many entrepreneurs improve their communities and their personal well-being by offering services to neglected areas or by manufacturing eco-friendly items. As a result of their work, communities may be revitalized and social and economic development may be accelerated.

### **3.5.8 Optimal Use of Resources:**

Finding new possibilities in the market and making the most efficient use of available resources are two areas where entrepreneurial spirit may shine. Innovative goods and services that address consumer requirements while making the most of available resources are also greatly aided by entrepreneurs.

### 3.5.9 Enhances GDP and Personal Income:

The growth of an economy and the number of employments it generates may significantly affect a country's GDP and PCI, two indicators of economic health. PCI determines the average income per person, whereas GNP assesses a country's entire economic production. An increase in PCI may result from a growth in GNP. Entrepreneurship has the potential to boost GDP by launching new companies and sectors, which in turn may increase consumer spending, tax revenue, and the number of jobs available.

## IV. CONCLUSION

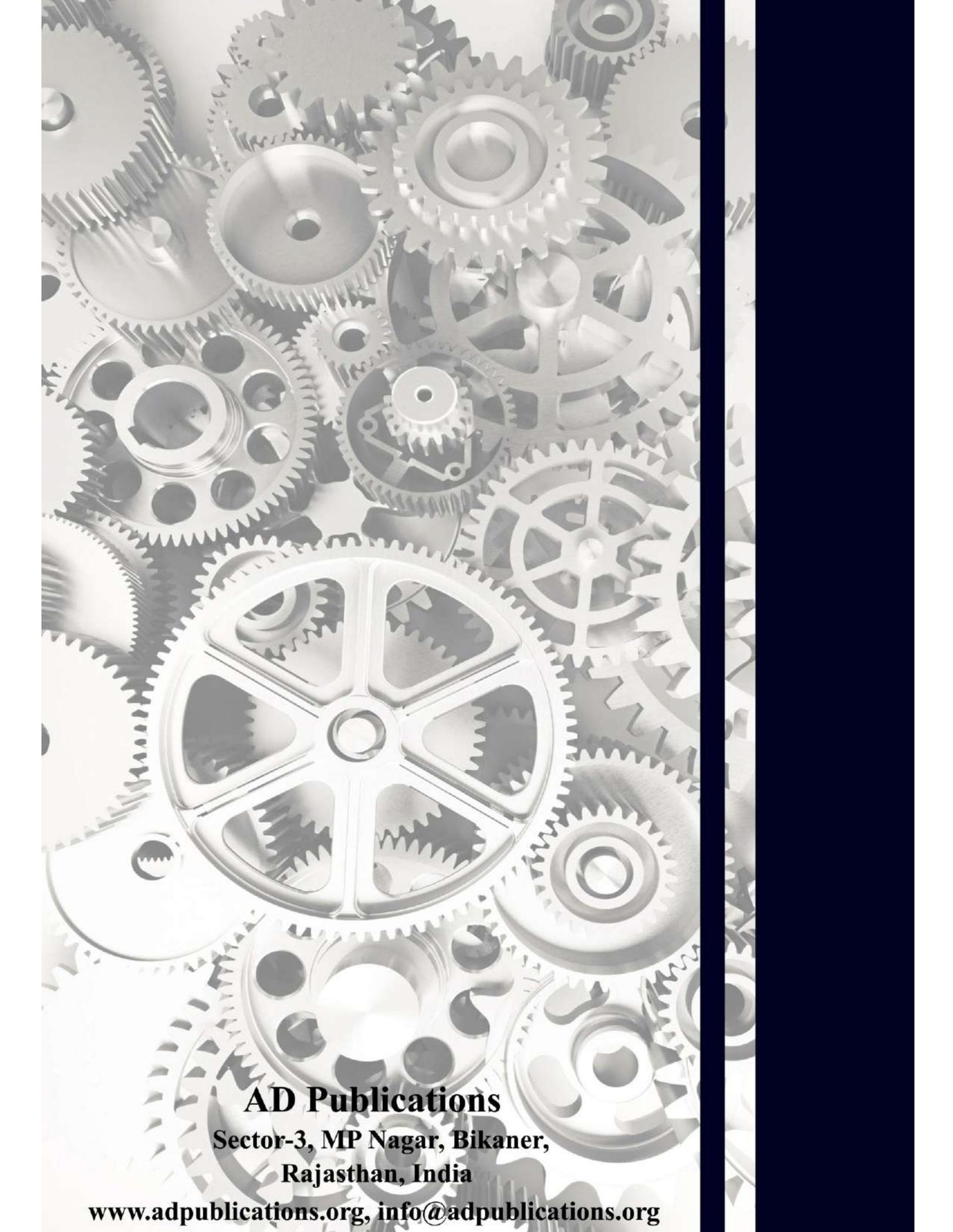
Entrepreneurship negatively impacts progress for emerging nations in the medium term, whereas it has no noticeable effect on industrialized ones. Developed and emerging nations alike see innovation as having little to no effect on economic progress. The Favourable effects on development of both entrepreneurship and innovation suggest a mutually supportive relationship between the two. However, both sets of nations see a favorably substantial effect of long-term development via starting a business. Developed nations saw a shift from a negligible short-term effect of innovation on growth to a positive long-term effect. The density of new businesses and funding for scientific inquiry and technological advancement per capita are two indicators of entrepreneurial spirit and innovation, which are seen as important tools for boosting economies worldwide. Because the effects of innovation and entrepreneurship take time to react to, governments must exercise patience. The short-term setbacks will be more than offset by the long-term gains. What this means is that the time frame is crucial. Governments should simultaneously encourage innovation and entrepreneurship for the greatest results. In order to reap the full advantages of innovation, developing nations should prioritise measures to strengthen patent protection laws, increase the efficiency of research and development, etc.

## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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