IJNRD.ORG ISSN : 2456-4184
INTERNATIONAL JOURNAL OF NOVEL RESEARCH AND DEVELOPMENT (IJNRD) | IJNRD.ORG
An International Open Access, Peer-reviewed, Refereed Journal

# IMPLEMENTATION OF INDUSTRY 4.0 IN SECOND WORLD NATIONS: A COMPARATIVE STUDY ON GERMANY AND ROMANIA

**Sangeeta Sambhi** [1]
B.Sc. Economics Student, (USB) Chandigarh University

**Dr. Pushpak Sharma**[2]
Assistant Professor, Chandigarh University

## Abstract

Industrial Revolution 4.0, initiated by Germany, as an idiosyncratic concept has not been tough to rumble pan globe. However, its adoption and application, is facing set-backs, especially in upper income developing nations, with an immense potential for development of a strong manufacturing base. This study has been conducted, to analyze the differences in the distant and gap-riddled development of Industrial Revolution 4.0, in Germany's counterpart, i.e., Romania. In this study, Germany as a developed nation, has been compared, to the developing nation of Romania, both of them being main exporters of automotive parts, and members of EU. They are labeled as second world nations, on the basis of Second World War's definition, which indicates the presence of deadly wars aspect in shaping the countries of study. Germany sailed through the difficulties posed by its adoption, but, Romania has a crippled growth due to existence of twin-deficits. Multivariate Regression Model, has indicated, that mirroring of Mittelstand Model of Germany, in Romania, will improve its functional optimality. Thus, balancing Macroeconomic Variables, promoting sustainable, and cost-cutting measures of producing valuable products, establishing efficient supply chain management, and incubating innovative business ideas.

**Key Words:** Industry 4.0, IIoT, Mittelstand Model, Twin-Deficit, Revolution, Smart Factory.

The current research paper has been divided into five main sections, first one being the introduction. It is followed by: research methodology, analysis, expansion path, and conclusion, consecutively.

## 1.Introduction

The fourth industrial revolution, popularly known as industry 4.0, is an innovative and progressive outcome of previous three revolutions, which changed the dynamics of manufacturing, *(Crnjac M, 2017)*. It is a concept, which applies logistics

of machine learning, to make real-time decisions on the efficiency, cost-cutting policies, and sustainable methods of production, for a firm, related to information systems, packaging, supply-chain management, automotive car parts, as found out by *(Abiodun, 2023)*. Industry 4.0 was publicly announced by German Government, in collaboration with the Ministry of Education and Research *(BMBF),* and, Ministry of Economic Affairs and Energy *(BMWI),* in the year of 2011. Strategy 140, is an initiative taken by the stakeholders, which aims at integration of cyber physical systems *(CPS),* and Internet of Things and Services *(IoTS),* with an eye to enhance productivity, efficiency and flexibility of production processes and, thus, economic growth, as implied by *(Erboz, 2023).*Industry 4.0 is an accumulation of two different sectors, belonging to the same vertical. It operates at the intersection of Information Technology *(IT)*, and Operational Technology *(OT),* thus, interconnecting autonomous manufacturing equipment, and broader computer systems, using lean technology, as proposed by *(Ilangakoon, 2022).*The tools which are exclusively introduced under the Industry 4.0, and widely accepted, are: Cloud Computing[i], Internet of Things *(IoT)*[ii], Smart Factories[iii], and Internet of Services *(IoS*[iv]*)*.

A study has found out, that the application of Industry 4.0 is open to all the countries, but, its viability is guarded by developed countries, and hence, blocked by economic, social, and political crisis for the upper income developing countries, *(Min, 2019)***.**

It is interesting to understand, how the second world countries came into existence. The temporal evolution of nations, according to the labour force distribution, in multi-dimensional phases, shows how the socio-economic cultural base of nations were formed, *(Robertherman, 1972)*. While Germany being a member of the Soviet-Bloc, was the aftermath of World War II, Romania was also a part of the Soviet-Bloc, and had significant contribution in the cold war. Hence establishing diplomatic relations with Eastern Germany, in the year 1967. Since then, both the countries have successfully passed the four stages of development of Industrial Revolutions, respectively, a study by *(Dutta, 2007)* states. And with mild conflicts happening now and then, Germany attains the stature of being a developed country, and Romania still continues to be a developing country, pertaining to rising political, economic issues causing a hike in inflation. Industry 4.0 is welcomed with whole lot of positivity, by nations all over the globe, but the miserable reality is, that its tools, are only seen to be functional in financially, politically, and socially strong nations, *(Čater, 2021)*. In these nations, the employee competency has been seen to rise, and the motive to use these tools, has been marked as creating better, and more reliable value chains. The four drivers of Industry 4.0 include, Technology, Organization, Human Capital, and Strategy, *(Brissaud, 2021)*. Internet of Things (IoTs) poses both challenges and reaps benefits for being applied to the economy of an industry, *(Müller, 2018)* .

Germany is known for the mid family sized firms that exist, in the form of Mittelstand, contributing significantly, to the revenue generation. Mittelstand Model is responsible for accumulating net savings in smaller amounts, and then paving the way for significant capacity building, as stated by *(Kang, 2022).* The implementation of industry 4.0, is creating extensive external economies, paving the path for a flexible corporate culture, creating a more open-minded approach towards solving the contemporary complex small scale, and medium scale business solutions, as stated by *(Brodeur, 2023)*. Furthermore, it is observed that, planning processes, cooperation with external partners, proper handling of data interfaces, interdisciplinary communication, an adaptable organizational structure, and data security, accumulate to priorities of prime importance to German manufacturing Enterprises, *(Kiel, 2019)*. A study indicates, that it is MSMEs that contribute largely to German economy, *(Yu, 2020)*.

However, it is argued, that where on one side the developed and developing nations like Germany and Romania have the potential to face the strides of obstacles Industry 4.0 brings with its implementation, the underdeveloped nations, have little

to no existence of a structural committee to support its actions, *(Kovaleski, 2019)*. There is a lack of scientific analysis, of how the Automated Industries and Machine Learning prospects, can change the entire economic outlook of a nation in Romania, *(Giurca Vasilescu, 2008)*. It is realized that Romania is a source of great potential, for the successful implementation of Industry 4.0, but *(Türkeş, 2019)* states, that along with physical structures being installed in the economy, there also needs to be knowledge imparted, strategy for maintenance made, and proper planning procedure to take place, to establish the notion of interdisciplinary development taking place.

Romania is considered to be a victim of skill-vandalism, and twin-deficit. The workforce lacks the required skills to operate the respective machinery. On the contrary, Government needs to incur extra amount of expenditure on training the workforce, with Vocational Skills, also introducing new curriculums, other than the basic ones. Hence, to improve the state-of-arts, this process leads to a loss-inhibited cycle of skills and management, in the developing nation of Romania, *(Moldovan, 2018)*.

The most significant area of implementation, is realised to be that of Manufacturing, and Equipment Industry. AI is on the path of transforming the contemporary regime of manufacturing and work-culture, in the field of advanced robotics, and Business Analytics, thus creating better international relations between countries, and reducing the knowledge, skill, and income gap, across communities, *(Gumbo, 2023)*. Overall, the tools of Industry 4.0, have a bright future, in its implementation in the automotive sector, *(Montemayor, 2023)*. Scope of a circular economy being created, is realized, wherein, optimum resource management is done.

In the context of above-mentioned lines, this research paper majorly focuses on the level of operational efficiency of Mittelstand Model of Germany, being mirrored to the Romanian Economy. For this purpose, the study delves into devising methods, of removing bottlenecks in the upper income developing countries, from its implementation. A comparative study has been conducted, wherein, Germany has been taken as a developed country, and Romania as a developing country, condition applied, Mittelstand Model of mid-sized firms, used by Germany to accumulate Net National Savings, for investment in installation of Industry 4.0, is mirrored into Romanian Economy, to remove the problem of twin-deficits, inflation, skill-vandalism, and political conflict, existing in the country, concluded by a study conducted by *(Mirdala, 2015)*.

The objectives of the current study, are: to find out, whether the implementation of Mittelstand Model in Romania, surges the unit increase in GDP, with improvement in Macroeconomic factors, like: Value of Exports, Political Stability, Investment in Education, and Expenditure on IT. And, to analyse the expansion path of Industrial Revolution 4.0, in both Germany and Romania.

## 2. Research Methodology

A ***Multivariate Linear Regression Model*** is being tested with the motive of formulating hypothesis of a case, wherein, the Romanian economy mirrors the strategy of successful implementation of German Model of Mittelstand, into their economy. For this purpose, multivariate regression equation has been formulated, which entails one dependent variable, and four independent variables. ***Pearson Correlation*** will also be checked, in order to analyse the level of relatability, amongst the variables, like; GDP, with Export, Political Stability, Investment in Education, and Expenditure on IT sector. The choice of variables has been purely made for accessing the Economic, Political, and Social stance of Romanian Economy.

The variables along with regression equation have been mentioned below.

***GDP = a + b1*Export value per exporter + b2*Political Stability in Romania + b3*Investment in Education + b4*Expenditure on IT Sector + E***

## 3.Analysis

Mittelstand model formulates the basic premises, on the face of which, a comparative study between Germany and Romania has been conducted. Multivariate Regression Model has been designed, to find out, if the independent variables, like: Improved Export Quality, Political Stability, Investment in Education, and Expenditure on IT, as a result of mirroring Mittelstand Model, into Romanian Economy, would increment unit increase in its GDP, for accumulating Net National Savings. The aforementioned macroeconomic variables have been considered as they are symbolic of Romania's current economic condition. Analysis has been conducted using secondary data, for a time period of ten years (2011-2021).

***Table 1*** *- Pearson Correlation Matrix*

| Parameters | Variables | GDP | Export | Expenditure-_on_IT | Political_ Stability | Investment-_in_Education |
|---|---|---|---|---|---|---|
| | | | | | | |
| Pearson Correlation | GDP | 1 | 0.58 | 0.277 | 0.61 | 0.46 |
| | Export | 0.58 | 1 | 0.14 | 0.689 | 0.324 |
| | Expenditure_on _IT | 0.277 | 0.14 | 0.1 | 0.27 | 0.263 |
| | Political_Stability | 0.61 | 0.689 | 0.27 | 1 | 0.006 |
| | Investment_in_Education | 0.46 | 0.324 | 0.263 | 0.06 | 1 |
| | | | | | | |
| Sig. (1-tailed) | GDP | | 0.031 | 0.205 | 0.023 | 0.077 |
| | Export | 0.31 | | 0.34 | 0.01 | 0.166 |
| | Expenditure_on_IT | 0.205 | 0.34 | | | 0.217 |
| | Political_Stability | 0.023 | 0.1 | 0.211 | | 0.493 |
| | Investment_in_Education | 0.77 | 0.166 | 0.217 | 0.493 | |
| | | | | | | |
| N | GDP | 11 | 11 | 11 | 11 | 11 |
| | Export | 11 | 11 | 11 | 11 | 11 |
| | Expenditure_on_IT | 11 | 11 | 11 | 11 | 11 |
| | Political_Stability | 11 | 11 | 11 | 11 | 11 |
| | Investment_in_Education | 11 | 11 | 11 | 11 | 11 |
| | | | | | | |
| | | | | | | |

*Compiled on the basis of secondary data.*

***Inference drawn from Pearson Correlation***

It can be realized, that in the absence of multicollinearity, there is a positive trend built, between one dependent, and four independent variables. With the implementation of Mittelstand Model in Romania, the indicators of growth in an economy, are at a better stance. The values attained from Pearson correlation, referring to table-1, can be read as: export has a positive and moderate correlation with GDP - .580, expenditure on IT has a positive and moderate correlation with GDP - .277, political stability has a positive and moderate correlation with GDP - .610, investment in education has a positive and moderate correlation with GDP - .460

The problem of twin deficits, has a large chance of being settled. The skill gap that has existed, between the labour force, and the usage of advanced machinery, will also be reduced. With investment in the IT sector, there is seen, a surge in the

amount of employment opportunities for skilled youth, and with exports, great amount of self-reliance can be established, which will contribute towards curbing unreasonable hike of inflation in Romania. Entrepreneurial education based upon improving family-owned technology-based business imparted in collaboration with European Union, pivots around bringing down the skill gap, a study by *(Stănciulescu, 2021)* demonstrates.

***Table 2*** *- Model Summary*

| Model | R | R_ Square | Adjusted_ R_Square | Std_Error_ of_Estimate | R_Square _Change | F_ Change | Df1 | Df2 | Sig_F _Change | Durbin_ Watson |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| 1 | 0.922 | 0.85 | 0.75 | 0.3046 | 0.85 | 8.517 | 4 | 6 | 0.012 | 1.486 |
| | | | | | | | | | | |

*Compiled on the basis of secondary data.*

***Hypothesis***

**H (0)** ***[Null Hypothesis]:*** There is no significant positive change in the smooth implementation of tools of Industrial Revolution 4.0, in Romania, when the German model of lump sum investment in the short run, on sectors of national importance, reaps higher returns in the longer run, thus, improving the revenue building of Romanian Economy.

**H (1)** ***[Alternate Hypothesis]:*** There is a significant positive change in the smooth implementation of tools of Industrial Revolution 4.0, in Romania, when the German model of lump sum investment in the short run, on sectors of national importance, reaps higher returns in the longer run, thus, improving the revenue building of Romanian Economy.

***Inference drawn from Model Summary***

After applying the decision rule to Table-2, it can be estimated, that the **Null Hypothesis [H0] will be rejected,** as **0.012 < 0.05.** This indicates, that when mirrored the Mittelstand Model of Germany, into Romania's Economy, it will contribute significantly towards improving the status of imbalanced Macroeconomic Variables. The value of **Durbin Watson is 1.486**, which indicates the **absence of autocorrelation**, there is low correlation between the independent variables. The value of **R-Square is 85%,** which indicates the data for testing, is a **good fit**. Value of **Adjusted R-Square is 75%**, which indicates relative proximation of data.

There is a significant positive change in the smooth implementation of tools of Industrial Revolution 4.0, in Romania, when the German model of lump sum investment in the short run, on sectors of national importance, reaps higher returns in the longer run, thus, improving the revenue building of Romanian Economy.

When a small sizeable investment is made into the economy, the chances of these investments failing, has a mild impact on the overall net savings. Whereas, on the same lapse of happenstance, when a large amount of investment fails, the impact on national income, as well as output is huge. This is what the model aims to make the readers understand.

Hence, improving functional operability of factors like; (i) Export, via improving its quality, (ii) Political Stability, by ensuring minimum autonomy of Government in controlling the operation of mid-sized firms, as also suggested in a study, conducted by *(Aioanei, I, 2006)*. (iii) Expenditure on IT sector, in terms of installing the advanced machinery required for the smooth function of Industry 4.0 ideals, and (iv) Investment in Education, in order to remove the skill gap that exists in Romanian youth, to operate these advanced machineries, being installed.

***Table 3*** *- Coefficients Table*

| Model | Unstandardized_ Coefficients_[B] | Unstandardized_ Coefficients_[Std_Error] | Standardized_ Coefficients_[Beta] | t | Sig. |
|---|---|---|---|---|---|
| | | | | | |
| 1 (Constant) | 11.387 | 2.413 | | 4.719 | 0.003 |
| Export | 1.87 | 0.571 | 0.878 | 3.287 | 0.017 |
| Expenditure_IT | 0.203 | 0.159 | 0.238 | 1.278 | 0.009 |
| Political_Stability | 0.019 | 0.079 | 0.063 | 0.24 | 0.019 |
| Investment_Education | 1.175 | 0.306 | 0.682 | 3.838 | 0.009 |
| | | | | | |

*Compiled on the basis of secondary data.*

***Inference drawn from Coefficients Table***

Referring to table-3, **Null Hypothesis [H0] is rejected in the case of Exports, 0.17 < 0.05**. Which indicates, that it contributes, significantly and positively, to the GDP of Romania, after the implementation of Mittelstand Model. There is an increase in the Exports by one-unit, will increase the level of GDP, by one unit.

**Null Hypothesis [H0] is rejected in the case of Expenditure on IT, 0.009 < 0.05**. Which indicates, that it contributes, significantly and positively, to the GDP of Romania, after the implementation of Mittelstand Model. There is an increase in Expenditure on IT by one-unit, will increase the level of GDP by one unit.

**Null Hypothesis [H0] is rejected in the case of Political Stability, 0.019 < 0.05**. Which indicates, that it contributes, significantly and positively, to the GDP of Romania, after the implementation of Mittelstand Model. There is an increase in Political Stability by one unit, will increase the level of GDP by one unit.

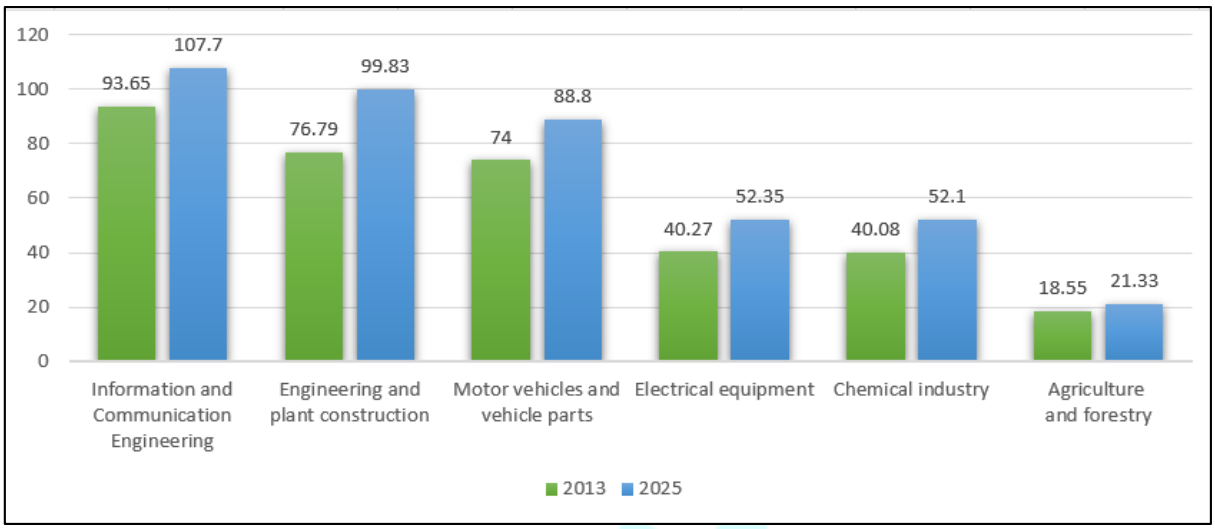
**Null Hypothesis [H0] is rejected in the case of Investment in Education, 0.009 < 0.05.** Which indicates, that it contributes, significantly and positively, to the GDP of Romania, after the implementation of Mittelstand Model. There is an increase in the Investment in Education by one unit, will increase the level of GDP by one unit.

Therefore, from the above stated statements, it can be concurred, that all the independent variables, i.e., Export Value, Political Stability, Investment in Education, and Expenditure on IT, will positively inch towards significantly contributing towards the surge in the value of dependent variable, i.e., GDP of Romania. A study conducted by *(Khan, Umar, Asadov, Tanveer, & Yu, 2022)* showcases, the benefits of utilizing Industry 4.0 tools, for establishing a remunerative circular economy.

## 4. Expansion Path of Industry 4.0 in both German and Romanian Economy

Germany experiences a cut in the cost of production, between 10% to 15%. And the automotive industry, holds the prospects of contributing 74 billion euros, back in 2013, to contributing 88.8 billion euros, in 2025. However, IT Sector, Construction Sector, Electrical Equipment Sector, and, Chemical Industry, also show great potential for effective use of IIoT, after its successful implementation in Automotive Industry. Looking at its expansive future prospects, an estimate of its increased adoption between the year 2013, and 2025 has been showcased in figure-1. The growth prospects of Industry 4.0 for manufacturing firms, in Germany, has also been given a green signal in a study, conducted by *(Sarbu, 2022). (Figure-1 entails expansion path of four additional years from the period of study)*

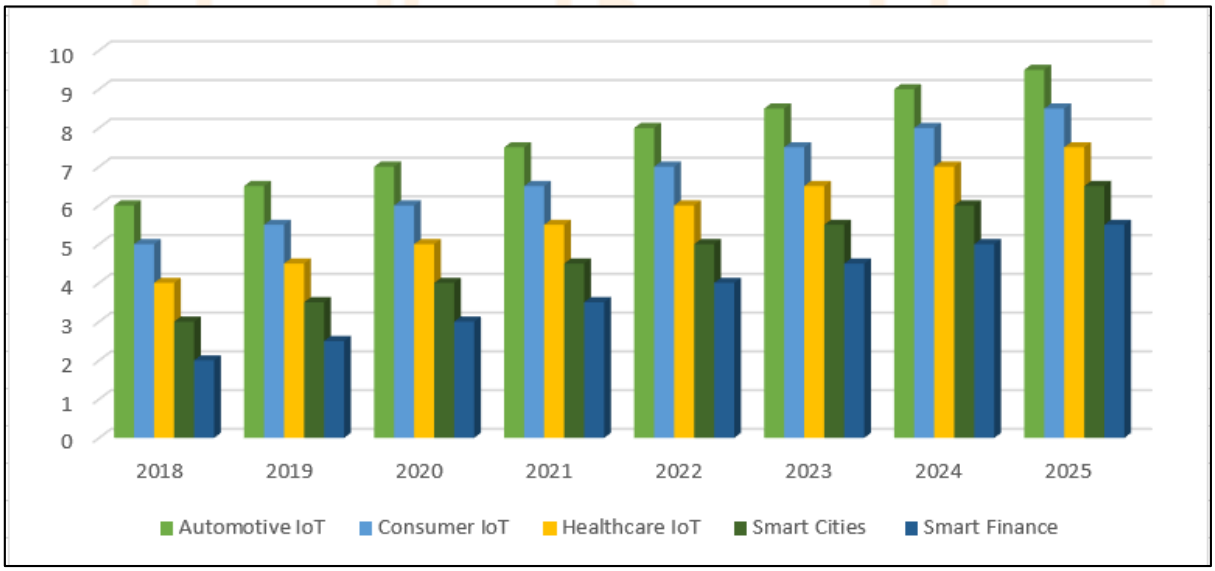
***Figure 1*** *– Higher acceptance of predicted scope of industry 4.0 in Germany between 2013 and 2025*




*Source: Statista comparative informetric on growth of industry 4.0 in 2013 and 2025*

Referring to figure-2, in Romania, the cost-cutting prospects, are still at a low rate of 3% to 5%. Nonetheless, Romania has a lot of constructive scope of increasing its revenue generation share in Automotive IoT, by 2025, along with channelizing minor investments, in other sectors of economic importance, like Industrial IoT, and Smart Finance. A study conducted by *(Lăzăroiu, 2022)* showcases, the industry 4.0 tools being used extensively, in the field of remote sensing, and other computer algorithms, of national importance, with an increased scope of its adoption, in the next five years. *(Figure-2 entails expansion path of four additional years from the period of study)*

***Figure 2*** *Expansion path of tools of Industry 4.0 in Romania between 2018 to 2025*




*Source: Statista Revenue per Segment*

## 5. Conclusion

The highest sectoral job contribution in Romanian GDP, comes from Services Sector, and Recruitment Sector, which, in its counterpart's case, comes from Mid-Sized family-owned businesses. The sectoral job contribution is important, as it forms the basis for generation of Net National Savings, which is further invested into producing Net National Output. It is

important, that Romania focusses more on its manufacturing abilities, as they will provide Romanian youth, with various opportunities of employment, and will increase the number of entrepreneurs operating individually, which will increase the chances of Romania being self-sufficient, reducing the amount of imports for consumer goods, and exporting more, hence, ultimately leading to cancelling out of the problem of Twin Deficit.

Furthermore, the Mittelstand Model of Germany, if mirrored in the Romanian Economy, will spread its progressive benefits, in leaps and bounds, as this model, takes into account little government autonomy. These mid-sized firms, are the main reason, behind the accumulation of ample amount of savings, in order to ensure, the smooth functioning of large corporations, producing and exporting, quality automotive parts, thus, bringing the BOP *(Balance of Payments),* to equilibrium. It is important to understand, that at the first instance, a nation should depend upon its internal economies, to be strengthened, in a manner, that they become the backbone of the nation's economy.

The main problem, that Romania faced, was skill gap, between the machinery installed, and skills held by Romanian labour force. When this model will be mirrored into Romanian Economy, its strength, which is strong ICT *(Information and Communication Technology)* sector, with 6% to 7% contribution, will be polished by manifolds, and will lead to increased investment in skill training, creation of more employment opportunities, expansion in the market for production of automotive parts, which will in return, create a safe and sustainable environment of work.

Thus, Implementation of Industry 4.0, in Romania, under the umbrella of Mittelstand Model, will create progressive opportunities for Romania, including; international cooperation on digitalisation of Manufacturing and other industries, adherence of industry players to existing and future EU *(European Union)* cooperation schemes, along with emergence of profitable value chains, and building a credible, and responsible workforce, with the promotion of educational programs, in collaboration with EU, thus, reducing social differences, providing economic, and political stability to Romania, also promoting the idea of sustainable production.

## References


1. Abiodun, T. R. (2023). Driving smartness for organizational performance through Industry 4.0: a systems perspective. *Journal of Manufacturing Technology*, Vol 34, No, 9, PP 40-63.
2. Aioanei, I. (2006). *Journal of Organizational Change Management,, Emerald*, Vol. 19 No. 6, pp. 705-712.
3. Brissaud. (2021). Designing industry 4.0 implementation from the initial background and context of companies. *Emeral*.
4. Brodeur, J. D. (2023). Organizational changes approaches to facilitate the management of Industry 4.0 transformation in manufacturing SMEs. *Journal of Manufcturing Technology Management* , Vol. ahead-of-print No. ahead-of-print.
5. Čater. (2021). Industry 4.0 technologies usage: motives and enablers. *Emerald*.
6. Crnjac M. (2017). From concept to the introduction of industry 4.0. *International Journal of Industrial Engineering and Management (IJIEM)*, Vol 8, page 21-30.
7. Dutta, M. (2007). Historical Progression of the European Union. *European Union and the Euro Revolution (Contributions to Economic Analysis, Vol. 283), Emerald Group Publishing Limited*, pp. 31-54.

8. Erboz, G. a. (2023). The role of Industry 4.0 on supply chain cost and supply chain flexibility. *Business Process Management Journal* , Vol. ahead-of-print No. ahead-of-print.

9. Giurca Vasilescu, L. (2008). Corporate governance in developing and emerging countries. The case of Romania. *Munich Personal RePEc Archive*.

10. Gumbo. (2023). Skills provisioning for the Fourth Industrial Revolution. *Elsevier*.

11. Ilangakoon, T. W. (2022). Adoption of Industry 4.0 and lean concepts in hospitals for healthcare operational performance improvement. *International Journal of Productivity and Performance Management*, Vol. 71 No. 6, pp. 2188-2213.

12. Kang, D. P. (2022). Digital-IIoTs spheres approach toward public development: an exploiting fuzzy-grey mathematical modeling of IIoTs spheres. *Grey Systems: Theory and Application*, Vol. 12 No. 2, pp. 389-416.

13. Khan, S., Umar, M., Asadov, A., Tanveer, M., & Yu, Z. (2022). Technological Revolution and Circular Economy Practices: A Mechanism of Green Economy. Sustainability. *Google Scholar* , 14, no. 8: 4524.

14. Kiel, J. W. (2019). *Lessons learned from Industry 4.0 implementation in the German manufacturing industry.* Germany : Google Scholar.

15. Kovaleski, J. L. (2019). *Implementation of Industry 4.0 concept in companies: empirical evidences.* Chicago: Google Scholar.

16. Lăzăroiu. (2022). Computer Vision Algorithms, Remote Sensing Data Fusion Techniques, and Mapping and Navigation Tools in the Industry 4.0-Based Slovak Automotive Sector. *Google Scholar*, Volume 10, no. 19: 3543.

17. Min, Y.-K. (2019). A comparative study on industrial spillover effects among Korea, China, the USA, Germany and Japan. *Industrial Management & Data Systems*, Vol. 119 No. 3, pp. 454-472.

18. Mirdala, R. (2015). Twin Deficits in European Transition Economies. *Neo-Transitional Economics (International Finance Review, Vol. 16), Emerald Group Publishing Limited, Bingley*, pp. 299-333.

19. Moldovan, L. (2018). *STATE-OF-THE-ART ANALYSIS ON THE KNOWLEDGE AND SKILLS.* Romania: Google Scholar.

20. Montemayor. (2023). Automotive Industry's Circularity Applications and Industry 4.0. *Elsevier*.

21. Müller, D. K.-I. (2018). *The Role of Opportunities and Challenges in the Context of Sustainability.* Germany: Google Scholar.

22. Robertherman. (1972). *A MannerofCharacterizingtheDevelopmentofCountries.* Michigan: Google Scholar.

23. Sarbu, M. (2022). The impact of industry 4.0 on innovation performance: Insights from German manufacturing and service firms,. *Elsevier*, Volume 113, 102415.

24. Stănciulescu, G. a. (2021). "The Role of Entrepreneurial Education in the Development (and Success) of Family-owned Technology-based Businesses in Romania". *Emerald Publishing Limited, Bingley*, pp. 39-65.

25. Türkeș, M. C. (2019). *Drivers and Barriers in Using Industry 4.0: A Perspective of SMEs in Romania.* Romania : Google Scholar.

26. Yu, F. (2020). Industry 4.0 technology implementation in SMEs – A survey in the Danish-German border region. *International Journal of Innovation Studies*, Volume 4, Issue 3, September 2020, Pages 76-84.

## End Note

[i] Cloud computing is the information being accessed, which is found remotely in a virtual space. Companies that provide cloud services, enable users to store files and applications on remote servers, and then access all the data via the Internet. This means the user is not required to be in a specific place to gain access to it, allowing the user to work remotely. The internet becomes a cloud, with which user can access the data and applications, from any device, provided it is connected to the internet, working from anywhere in the world. *Example:* Manufacturers can use cloud computing, to merge product planning and development information into supply chain data, and communication channel, for receiving speedy and cost-efficient output production.

[ii] Internet of Things *(IoT),* is a term used for network of physical objects, that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet. *Example:* Wearables, Phones, Television, Appliances, Home Monitoring, Health Care, Factories, Automation, Smart Cities, Transportation, and Heavy Machinery being attached to internet, via various channels.

[iii] Smart Factories are virtual workspaces, which use Internet of Things *(IoT),* to produce the best product, at minimum rate, and that too, efficiently. They are flexible, and dynamic in approach, and intelligent in action. Most of the smart factories have sensors attached to them, which realize the needs of a customer, and once the command is given, they process it, smoothly. These systems improve themselves through autonomous decision making, and self-optimization. These systems use Artificial Intelligence *(AI),* and Machine Learning, to extract, analyse and process data. *Example:* The most common example of smart factories, is the autopilot mode, found in Tesla Car. This system allows the vehicle to steer itself in a lane, detect traffic and slow down or speed up accordingly, and even change lanes and exit freeways without the driver having to touch the steering wheel.

[iv] Internet of Services *(IoS),* refers to a term wherein the parts of data, required to exchange or extract, are accessible through the public internet services. This may include the tools for development of a software, and other platforms, such as; servers, storage and communicators, to run the software, per se. *Example:* Examples may include, accessing the world wide web, information retrieval services, and communication services.