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Money Laundering and Its Consequences in a Transitional Economy – The Role of the Business and Financial Sector

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Abstract

Purpose – Money laundering is one of the most widespread phenomena in the financial world which is seriously threatening the integrity of system and representing a significant risk to a country's economic development, as well as its progress in geopolitical and infrastructural terms. In recent years, Bosnia and Herzegovina (B&H) has frequently appeared in various studies, articles, and media publications as one of the countries where this phenomenon is becoming more and more popular, and now we are witnessing that our country is being referred to as a "paradise" for money laundering. This research will focus on the role of Bosnia and Herzegovina's financial and business sectors, analyzing their role in the money laundering process and attempting to light up on some of the most common methods related to this phenomenon in Bosnia and Herzegovina.
Methodology/Research Approach – The research will be conducted using both qualitative and quantitative methods. A detailed analysis of secondary sources of information will be carried out, along with the collection of primary data on the given topic. A review of previously published works and relevant literature will also be conducted.
Limitations/Implications – The topic of this research is relatively unexplored and does not receive enough attention in the existing literature/studies, which presents a challenge in gathering needed data. The high unavailability of key information may limit the depth of analysis and accuracy of conclusions. Given the limited data sources, the research has been conducted in accordance with the available information from the approximately last 10 years, which may affect the scope and validity of the findings.
Practical Implications – This research contributes to a better understanding of the money laundering phenomenon, with a particular focus on the role of the business and financial sectors in Bosnia and Herzegovina. The research results can help in developing more effective strategies to combat money laundering, thereby reducing the harmful economic and social consequences that this phenomenon brings. Practical recommendations may include improvements in legal provisions and strengthening oversight and control in the business and financial sectors.
Originality – This research provides an original perspective on money laundering in the context of Bosnia and Herzegovina's business and financial sectors and encourages further discussions and deeper investigations. Previous studies can mostly be characterized as reviews, whereas this paper brings together all relevant macroeconomic variables and variables of interest in this case, offering a deeper insight into and addressing a previously unexplored area.

Keywords: money laundering, business/financial sector, macroeconomics, suspicious transactions, correlation analysis, banking and construction.

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1. Introduction

In the global economy, money laundering represents a serious challenge that goes beyond financial aspects and deeply affects the socio-economic structures of countries. In the context of transitional economies like Bosnia and Herzegovina, this phenomenon becomes even more pronounced due to its significant impact on institutional stability, infrastructure development, and investors trust, which is crucial for our country. Money laundering severely undermines the economic and monetary systems of every country, and Bosnia and Herzegovina is no exception. This work is carried out in multiple phases, and it is the responsibility of all bodies involved in this process to actively work on the prevention and suppression of this crime.

The financial system of Bosnia and Herzegovina faces serious challenges regarding trust and security, and society is confronted daily with scandals related to money laundering and various individuals, groups, and organizations. Understanding the functioning of this illegal process in our country is key to developing appropriate strategies and measures that will allow for the improvement of the economic system and the preservation of social stability. One of the main goals of this research is to create a clear and realistic picture of the current situation in Bosnia and Herzegovina, which is often referred to as one of the biggest "money laundromats" in the region.

Transitional economies like Bosnia and Herzegovina are especially vulnerable due to a lack of transparency, economic instability, weak regulations, and pressure from the international community. The lack of transparency and weak regulatory infrastructure facilitate money laundering activities, while economic instability creates an incentive for illegal activities to generate income.

This phenomenon gained popularity particularly in the past two decades, after Bosnia and Herzegovina recovered from wartime period. Increased exports/imports, foreign investments, a sudden rise in the construction of residential and commercial buildings, fiscal registers, unrealistic property prices, and so on are just some of the methods that have become the most common channels through which illegally acquired money is funneled into legal flows.

2. Money laundering as a concept

Among the many definitions of money laundering, which strive to describe this phenomenon as close as possible, the one that best reflects it is that money laundering is a process that attempts to make money from source A (illegal) appear as though it comes from source B (legal). In practice, the question arises: Who are the "money launderers"? Possible money launderers could be anyone involved in financial operations: bankers, lawyers, accountants, traders, and others who, knowingly or unknowingly, allow their business activities to be used for laundering money. For example, when an accountant falsifies actual accounting records to reduce or avoid paying taxes, or when a banker arranges a series of transactions aimed at avoiding the submission of a financial report (Raković, 2008).

This phenomenon first appeared between 1925 and 1931 in the United States, thanks to Al Capone, a famous American gangster. Although the practice of money laundering is not new, the terminology became popular thanks to Capone, who used money laundering as a method of hiding his illegal money. By purchasing laundromats, Capone was able to "wash" of the money earned from drug trafficking, prostitution, and tax evasion. However, the first forms of financial engineering and manipulating bank accounts appeared in 1934, when Swiss banks allowed anonymity for depositing money. Meyer Lansky continued expanding his money-laundering operations by purchasing his own offshore bank in Switzerland. Lansky used this bank as a tool for laundering money, allowing him to hide and legalize funds obtained from illegal sources.

3. Process

Money laundering is most commonly divided into three stages:

a) **Placement** is the first stage of money laundering, in which illegally obtained money is introduced into the legal financial system. In this phase, it is easiest to detect the appearance and nature of money laundering. It is also the riskiest stage for those laundering the money, as the "dirty" money is still "fresh" and connected to criminal activities, making it easy to uncover, especially when large amounts of money are involved.

The goal is to introduce the money into the system as quickly as possible to begin the process of concealment and legalization in later stages. Given that the financial system is the blood vessel of criminal activities, the actors and institutions involved in money laundering and financing terrorism try to exploit the movement of capital and services offered by the financial sector, which can harm the stability of the entire financial system (Lalić, Nović & Ubiparipović, 2022).

b) Layering

Layering is the second phase of money laundering, where the money that has already been introduced into the financial system is further concealed through a series of complex transactions. The aim of this phase is to "cover the tracks" of the money, making it nearly impossible to trace its original source. This is achieved by transferring the money between different accounts, often in different banks and countries, to complicate monitoring. Sometimes, it is also invested in fictitious companies or accounts that exist only on paper. The more layers of transactions there are, the harder it becomes to trace the money's origin. From this, it can be concluded that the goal of the second phase is to conceal the link between the money and the criminal activity from which it originates. During these transactions, a false perception is created that the transfer is made for the purpose of paying for goods or services abroad. Therefore, the person engaged in money laundering opens a company abroad, which later becomes a supplier and issues invoices to the company that holds the "dirty" money. However, the delivery of goods or services often does not occur, or if it does, it is in insufficient quantity or quality. In this case, only the transfer of money takes place (Budimir, 2020).

The most popular methods used by so-called money launderers or masterminds of such complex operations include: the establishment of fake companies, sending false import-export invoices, and transferring money to another bank, which is often owned by the money launderer (Iljkić, 2015).

c) Integration

Integration is the third and final stage of money laundering, in which the "cleaned" money becomes part of the legal economy and can be used without suspicion. In this phase, the money is often used for investments in legitimate businesses, such as purchasing real estate, opening companies, investing in stocks, etc. It can also be used for luxury purchases, such as cars, expensive items like jewelry, clothing, luxury trips, and so on. The goal is for the money to look as if it comes from legal sources, making it difficult to associate it with criminal activities. Once the money is integrated into the legal economy, it can be freely used without the risk of detection, at least until a detailed investigation into its source is conducted — something that is not typically carried out in our country, even though many suspicious individuals do not hide their wealth and have no 100% clear and logical origin for it.

4. AML System (in Bosnia and Herzegovina)

The history of the fight against money laundering (AML) goes back several decades and is closely related to global efforts to combat organized crime and terrorism. The development of the AML system began as a response to the failures of the "war with drugs" in the United States and South America during the 1960s and 1970s, when the sudden rise in drug trafficking created the most powerful criminal organizations in history. The first significant step in establishing the AML system occurred in 1989, when the G7 countries adopted the Paris Declaration, which laid the foundation for international cooperation in the fight against money laundering. This declaration highlighted the need for coordinated regulations, information exchange, and support between countries. In the following years, many countries adopted laws that obligated financial institutions to identify, monitor, and report suspicious transactions.

A key turning point in the development of the AML system occurred after the terrorist attack on 11 September 2001, when the United States and other countries realized the importance of stopping financial flows that support terrorist organizations. This led to the adoption of laws like the Patriot Act, which significantly expanded the obligations of financial institutions to prevent money laundering and terrorist financing. This event further strengthened international cooperation and encouraged the development of sophisticated AML systems worldwide (Lishan Ai, 2010).

While developed Western economies, such as the US and EU members, have set high standards and developed complex AML systems, transitional economies like Bosnia and Herzegovina face special challenges in implementing these measures. Political instability, corruption, and immature financial systems in (B&H) represent significant obstacles to the effective implementation of AML regulations. The lack of political stability can slow down the adoption and enforcement of necessary legal frameworks, while corruption undermines efforts to detect and punish money laundering. Although there are laws and regulations at both the state and entity levels that define AML obligations, their implementation often faces obstacles in the form of inconsistent regulations, lack of training and resources, and weaknesses in monitoring and enforcement.

In B&H, the institutions responsible for implementing AML policies include the Central Bank of Bosnia and Herzegovina, the Banking Agency of the Federation of B&H, the Banking Agency of RS, the Ministry of Internal Affairs, and the State Investigation and Protection Agency (SIPA). While some of these institutions have taken concrete steps in combating money laundering, their effectiveness is often limited due to weak capacities, lack of inter-institutional coordination, and low awareness among financial institutions and companies required to report suspicious transactions.

One important step in improving the AML system in B&H was aligning with international standards, including recommendations from the Financial Action Task Force (FATF). Through the adoption of laws like the Law on Preventing Money Laundering and Terrorist Financing, B&H has made progress in identifying and sanctioning illegal financial activities. However, to achieve full compliance with international standards, further strengthening of control and oversight mechanisms is needed, as well as training relevant staff in the financial sector to increase effectiveness in the fight against money laundering.

The special problem in Bosnia and Herzegovina is the lack of a unified database at the state and entity levels, which complicates the work of competent authorities in preventing all forms of crime. The legal framework for the exchange of information between different institutions and authorities is not harmonized, which further complicates intelligence work and information gathering. These weaknesses seriously affect the quality and quantity of intelligence work, which is crucial for strategic and operational purposes in preventing money laundering and financing terrorism. As a result, AML and CFT mechanisms in Bosnia and Herzegovina remain weak and

vulnerable to abuses, posing a significant threat to the economic stability and security of the country.

5. Importance of a database

In the previous part of the paper, where the AML system in Bosnia and Herzegovina was analyzed, the absence of a unified national database was identified. A national-level database is a key component in the fight against money laundering because it enables transparency, control, oversight, and easy access to data. What is of great importance in Bosnia and Herzegovina is also a register of beneficial owners, which is another type of database that would create control over ownership structures. Due to deficiencies and lack of transparency, there have been cases where several hundred companies were registered at one address, which clearly points to fictitious companies used for various financial manipulations.

In developed countries, a centralized database serves as a key tool for monitoring and preventing money laundering, allowing government bodies, regulators, and financial institutions to efficiently track and analyze operations in order to identify suspicious activities. Laws require all companies to register in a centralized database and report their beneficial owners, usually individuals with a 25% or more shareholding. This data is collected by beneficial ownership registries like the ones in the United Kingdom (PSC register) and in EU countries, in line with EU directives on preventing money laundering. These databases often employ automated tools and algorithms to track patterns in data that may indicate suspicious activities/outliers, such as frequent ownership changes, multiple companies registered at the same address, or owners involved in suspicious business activities.

6. Basel AML Index

The Basel AML Index, developed by the Basel Institute on Governance since 2012, ranks countries according to their risk of money laundering and terrorist financing (ML/TF). The ranking is based on 15 indicators collected from sources like FATF, Transparency International, and the World Bank, evaluating factors such as the development of AML/CFT systems, corruption levels, financial transparency, and legal challenges. This index does not measure actual money laundering or terrorist financing activities but rather analyze and rates countries' vulnerability to these risks and their ability to counteract them. It is a crucial tool that helps financial institutions and authorities make informed decisions by providing data on ML/TF risks at the country level. Although the index is not a precise measure of the amount of money laundering, it offers a broader view of risk levels. The index is updated annually to ensure accuracy and relevance, considering indicators like the level of corruption, which is a consequence of limited data availability for measurement.

Bosnia and Herzegovina appeared on the Basel AML Index in 2020 for the last time, with a score of 5.63, indicating a moderately high risk of money laundering and terrorist financing. This score places the country in the group of countries with significant challenges regarding transparency, the effectiveness of laws, and the control of financial flows. After 2020, Bosnia and Herzegovina no longer appeared on the list, which may be due to insufficient availability of updated data. The absence from newer reports makes it difficult to track progress in this area, highlighting the need for greater transparency and cooperation with international organizations to continue assessing and improving the regulatory framework.

7. Research focus

Following the introduction to the research, the explanation of the "money laundering" phenomenon and the AML system, and the analysis of the Basel AML Index for Bosnia and Herzegovina, further research will strictly focus on money laundering and its impact on the transition economy, with a particular focus on the construction sector in the business sphere and the banking sector in the financial sphere. The research question that the paper focuses on is: "What is the correlation between macroeconomic parameters, banking transaction reports, and the expansion of construction in the period 2015-2022?"

8. Literature review

In the paper "Pranje novca" by Jadranka Lalić, Stoja Nović and Suzana Ubiparipović (2022), the authors analyze the complexity of money laundering, which is defined as transferring illegally obtained money into legal financial flows. They emphasize the importance of criminalizing money laundering in the criminal legislation of Republika Srpska, as well as the stages of this process, which include placement, layering, and integration. The authors highlight the challenges posed by organized crime groups, which complicate the prosecution of money launderers. According to the paper, Bosnia and Herzegovina has made significant steps in meeting European anti-money laundering standards, removing it from the high-risk country list. A key measure in this process was the adoption of the Law on Preventing Money Laundering and Terrorist Financing. The authors explained various methods of money laundering, focusing on strategies used by individuals and legal entities. Common methods for individuals include unusual large cash deposits, remittances from abroad, and currency exchange transactions, while legal entities use more complex methods such as offshore zones, fictitious contracts, and front companies. The authors stress the need for continuous cooperation among relevant agencies and more frequent checks on the origin of funds to reduce money laundering risks in Bosnia and Herzegovina.

In *"Combating Money Laundering in Transition Countries: The Inherent Limitations and Practical Issues"* by Jun Tang and Lishan Ai (2010), the paper discusses the background of anti-money laundering (AML) efforts in transition countries, addressing the unique phenomena of "adopt but not implement" and "selective enforcement." It critiques the defensive reporting practices of financial institutions in these countries. Although many transition countries have taken actions against money laundering in the past decade, AML systems remain inefficient, driven mainly by international pressures and internal political needs.

The *Strategy and Action Plan for Preventing Money Laundering and Terrorist Financing in Bosnia and Herzegovina* (Ministry of Security, B&H) outlines the country's efforts, emphasizing the need for effective prevention in line with EU integration. It highlights the importance of close cooperation between law enforcement, judicial bodies, and other relevant institutions. Money laundering and terrorist financing are also closely tied to the private sector, requiring public-private collaboration.

The Basel Institute on Governance, an international non-profit organization, promotes anti-corruption and AML efforts. Their Basel AML Index helps assess the risk of money laundering and terrorist financing in different countries, including Bosnia and Herzegovina, based on factors such as political stability, the effectiveness of legal systems, corruption, and existing anti-money laundering measures.

In *The Negative Effects of Money Laundering on Economic Development* by Brent L, money laundering negatively impacts economic growth by undermining financial institutions, reducing productivity, and encouraging crime and corruption, which slows down development. It also distorts international trade and capital flows, harming long-term economic stability. For

developing countries, money laundering through offshore financial centers (OFC) undermines these centers' efficiency and growth. Effective AML policies can strengthen financial sectors and improve governance, essential for sustainable economic growth.

Milena Raković, in her paper "Pranje novca: Kako ga iskoreniti?" (2009), emphasizes that money laundering and terrorist financing are global issues. Countries are developing strategies and regulations to combat money laundering, aiming to prevent criminals from exploiting corrupt or unregulated institutions for illegal profits. Raković suggests measures such as educating stakeholders, improving transaction reporting, and using strong IT support for efficient monitoring and analysis of suspicious transactions. She also emphasizes the importance of Bosnia's anti-money laundering laws, including the requirement for entities to report suspicious transactions exceeding 30,000 KM to the Financial Intelligence Unit (FOO), which is part of the State Investigation and Protection Agency (SIPA).

Nemanja Budimir's paper "Pranje novca" (2020) discusses the global problem of money laundering and its implications at both national and international levels. The paper stresses the need for proactive strategies and laws to prevent criminals from using corrupt institutions. Prevention focuses on detecting perpetrators and protecting the country's economy and international financial flows.

Davor Iljkić, in his work "Pranje novca u domaćem i stranom zakonodavstv" (2015), analyzes money laundering as a transnational phenomenon and highlights the role of financial intelligence units in its prevention. The paper discusses the stages and methods of money laundering, including the purchase of shares, real estate, and the creation of black funds. It stresses the importance of aligning with EU recommendations and improving legislation to combat money laundering, referencing strategies used by developed countries such as Germany and the US.

The Financial Intelligence Unit (FOO) of the State Investigation and Protection Agency (SIPA) is the main body for financial intelligence activities in Bosnia and Herzegovina, operating in line with international standards for combating money laundering and terrorist financing. The FOO promotes cooperation among relevant authorities within Bosnia and Herzegovina and internationally, utilizing data to investigate suspicious transactions.

The Agency for Statistics of Bosnia and Herzegovina is responsible for collecting, processing, and publishing statistical data at the state level. It provides accurate and timely information necessary for decision-making in various sectors, including the economy. The data used in this research reflects Bosnia's macroeconomic situation, including GDP, CPI, and unemployment rates.

9. Methodology

This research focuses on analyzing the correlation between reported suspicious transactions and relevant parameters of construction expansion and economic indicators in Bosnia and Herzegovina from 2015 to 2022. The study is quantitative in nature and relies on secondary data. The focus is on finding correlations between variables describing the state of the targeted sectors and macroeconomic indicators such as GDP, CPI, and the unemployment rate. This approach aims to understand the impact of money laundering and financial irregularities on the country's economic situation.

Given the limited availability of data, all relevant data from publicly available sources such as the Financial Intelligence Unit of SIPA (FOO) and data from the Agency for Statistics of Bosnia and Herzegovina were used. A major limitation of the study is the unavailability of complete data for all variables in all years, as well as the fact that some private sector data and

transactions may not have been reported. Therefore, all available data were used to form the most relevant and accurate final findings.

The following methods were used for data processing:

- *Descriptive statistics* were used to summarize the basic characteristics of the collected data.
- *Correlation analysis* was applied to examine the mutual relationship between the collected data and macroeconomic variables.
- *Deviation analysis* was used to show deviations in the data, that is, the occurrence of extreme values (outliers) in certain years, which may indicate an increased likelihood of money laundering. These values will be marked in red.
- *Correlation analysis* will show the strength and direction of the relationship between these variables, to better understand the impact of reporting suspicious transactions and cash declarations on the country's economic situation. Pearson's correlation coefficient will be used to represent the relationship between the variables.

Pearson's correlation coefficient measures the strength and direction of the linear relationship between two variables. The coefficient value can range from -1 to 1, where:

- **1** indicates a perfect positive correlation (as one variable increases, the other also increases),
- **0** means there is no linear relationship between the variables,
- **-1** indicates a perfect negative correlation (as one variable increases, the other decreases).

Microsoft Excel was used for data analysis, enabling calculations and visualizations. Excel was chosen due to its accessibility and functionality in working with statistical data.

10. Results

This chapter presents the results of the research, analyzed using Pearson's correlation coefficient. The goal of the analysis was to examine the relationship between selected variables to determine the strength and direction of their connections. The focus was on key economic indicators in order to explore the impact and extent of money laundering in Bosnia and Herzegovina. Pearson's coefficient was used to determine whether there is a statistically significant correlation between these variables and to better understand the relationship between illegal activities and economic indicators in the country. Through this analysis, the results will provide insights into potential causal links and facilitate drawing relevant conclusions about the extent and effects of money laundering on Bosnia and Herzegovina's economy.

The results will be divided into two sections, where section:

A) presents the correlation of the financial sector, i.e., the number of total reports and suspicious transactions and their values with macroeconomic variables;

B) presents the correlation of the real sector, i.e., construction (value of construction works completed, number of buildings completed, gross value added, number of construction companies, and turnover) and macroeconomic variables.

A)

Table 1. Table of relevant transactions and macroeconomic parameters

Year	Number of reported suspicious transactions	Total value of suspicious transactions	BDP (mil.BAM)	CPI	Unemployment	Basel AML Index
2015	95 (I/VI)	9.558.418,23	28.586,000	104.0	551,167	5,64
2016	/	/	29.900,000	/	510,022	5,18
2017	528	64.529.918,78	31.376,000	103.8	501,522	5,91
2018	455	153.162.371,92	33.408,000	100.6	458,355	5,84
2019	737	98.262.436,16	35.229,000	101.2	401,846	5,83
2020	812	68.392.924,59	34.255,000	100.1	413,627	5,63
2021	1,048	129.552.072,31	39.107,000	102.1	415,027	/
2022	1,504	260.606.434,88	45.618,000	116.4	354,700	/

Figure 1. Graphic display (suspicious transactions – SIPA FOO) * data for 2016 is unavailable

a1) Suspicious Transactions/GDP; r=0.9721

The correlation between suspicious transactions and GDP reveals a strong positive relationship (r=0.9721). This suggests that as GDP increases, the number of reported suspicious transactions also rises. This may be due to increased economic activity, which leads to more financial transactions, thereby increasing the chances of identifying suspicious activities.

a2) Suspicious Transactions/CPI; r=0.6275

The correlation between suspicious transactions and the Consumer Price Index (CPI) shows a moderate positive relationship (r=0.6275). This indicates that as inflation (CPI) rises, so do the reported suspicious transactions. Higher inflation may create conditions that facilitate or encourage money laundering.

a3) Suspicious Transactions/Unemployment; r=-0.9134

The correlation between suspicious transactions and unemployment reveals a strong negative relationship (r=-0.9134). As unemployment decreases, there is a significant increase in the number of reported suspicious transactions. This may reflect greater economic activity and a higher volume of financial transactions, which may prompt increased monitoring by regulatory authorities.

a4) Suspicious Transactions/Basel AML Index (2015-2020); r=0.167

The correlation between suspicious transactions and the Basel AML Index (2015-2020) indicates a weak positive relationship (r=0.167). This suggests a slight connection between countries with higher money laundering risk and more reported suspicious transactions. However, the low correlation indicates that factors such as regulatory improvements and financial system transparency play a significant role in the reporting of suspicious activities.

Table 2. Table of cash transactions and their values (2015 I/VI – 2022)

REPORTS ON CASH TRANSACTIONS		
Year	**Number of reports**	**Total value of reported transactions (BAM)**
2015 (I/VI)	184,873	8.252.438.069,91
2016	/	/
2017	478,832	19.192.755.516,65
2018	475,631	19.850.530.935,38
2019	391,888	19.882.869.921,29
2020	332,636	19.216.949.436,24
2021	409,290	24.534.898.265,09
2022	493,007	31.221.156.571,61

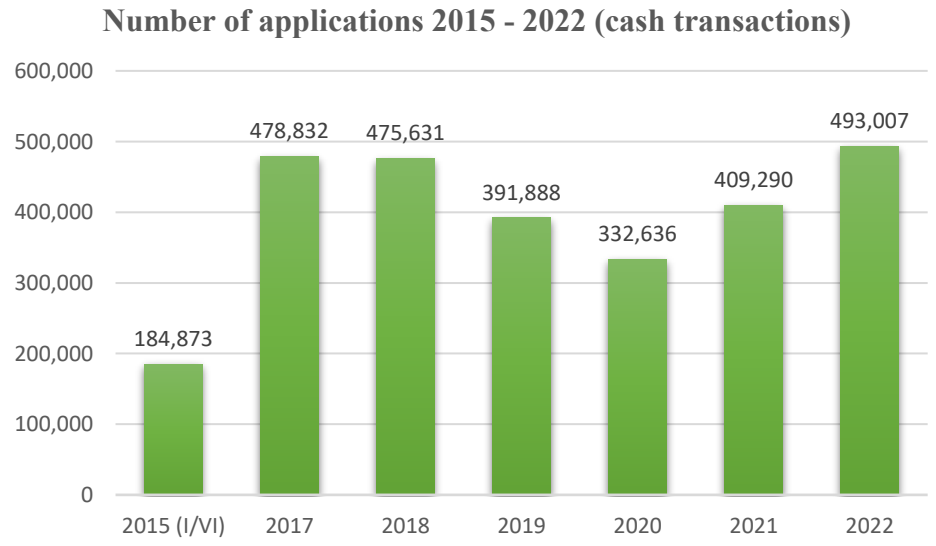

Figure 2. Graphic representation (cash transactions – SIPA FOO) *data for 2016 is unavailable

a5) Total Cash Transaction Reports/GDP; r=0.565

This value indicates a moderate positive correlation between the number of cash transaction reports and GDP. As GDP increases, so does the number of reported cash transactions, although the correlation is not strong enough to be considered direct. It suggests that economic growth may drive a higher volume of transactions, including suspicious cash transactions.

a6) Total Cash Transaction Reports/CPI; r=0.310

Here, a weak positive correlation is observed between the number of cash transaction reports and the Consumer Price Index (CPI). This implies that changes in inflation (CPI) have a minimal impact on the number of reported cash transactions. Inflation may have some influence on cash transaction activity, but it is not a key factor.

a7) Total Cash Transaction Reports/Unemployment; r=-0.544

This coefficient shows a moderate negative correlation between the number of cash transaction reports and unemployment. As unemployment increases, the number of cash transaction reports decreases. This suggests that higher unemployment may result in lower business activity and fewer suspicious cash transactions being reported.

a8) Total Cash Transaction Reports/Basel AML Index (2015-2020); r=0.861

A strong positive correlation is observed here, indicating a strong connection between the number of cash transaction reports and the Basel AML Index. This suggests that a higher number of reported cash transactions corresponds with an increased risk of money laundering, as reflected in higher Basel AML Index values. This strong correlation highlights the link between cash transactions and the risk of money laundering.

B)

Table 3. Table of values of completed construction works (2015-2022)

Year	Value of completed construction works in (B&H) (BAM)
2015	1.583.308.000 KM
2016	1.611.463.000 KM
2017	1.557.487.000 KM
2018	1.642.932.000 KM
2019	1.567.602.000 KM
2020	1.735.241.000 KM
2021	1.701.492.000 KM
2022	2.009.639.000 KM

Figure 3. Graphical presentation of the value of completed construction works for the period 2015-2022

b1) Value of Construction Works/GDP; r=0.868

This Pearson correlation coefficient of 0.868 indicates a very strong positive correlation between the value of completed construction works and GDP. As GDP increases, the value of construction works rises almost proportionally. This strong correlation suggests that economic activity and investment in construction play a crucial role in money laundering considerations, especially in the real estate sector, where money laundering is a common occurrence. High investments and growth in construction may serve as an indicator of potential financial irregularities.

b2) Value of Construction Works/CPI; r=0.799

The correlation coefficient of 0.799 indicates a strong positive correlation between the value of construction works and the Consumer Price Index (CPI). This means there is a strong connection between rising prices in the economy and increased construction activity. The high correlation between construction works and inflation suggests that price fluctuations (inflation) significantly affect this sector. This is important when considering the impact of macroeconomic factors on construction investments, which often play a key role in money laundering, particularly in the real sector.

b3) Value of Construction Works/Unemployment; r=-0.71

The Pearson correlation coefficient of -0.71 indicates a strong negative correlation between the value of construction works and the unemployment rate. As the value of construction works increases, the unemployment rate decreases, and vice versa. The strong negative correlation suggests that construction activities not only contribute to economic growth but also to the reduction of social issues like unemployment.

b4) Value of Construction Works/Basel AML Index (2015–2020); r=-0.214

The correlation coefficient of -0.21 indicates a weak negative correlation between the value of construction works and the Basel AML Index (Anti-Money Laundering Index). This finding suggests that while there is a small connection, it is not strong enough to conclude that increased activity in the construction sector directly increases or decreases the risk of money

laundering in Bosnia and Herzegovina. It may be useful to consider additional variables that could have a stronger impact on the Basel AML Index.

Table 4. Table of relevant parameters of construction expansion (2015-2022)

Year	Gross value added in thousands BAM (Construction)	Number of construction companies	Turnover (thousands of BAM)
2015	1.124.531	3.168	3.127.285
2016	1.172.668	3.791	3.276.243
2017	1.258.826	4.003	3.506.180
2018	1.366.647	4.049	3.779.132
2019	1.511.667	4.249	4.135.445
2020	1.617.266	4.451	4.348.986
2021	1.687.133	5.067	4.568.526
2022	1.977.307	***	***

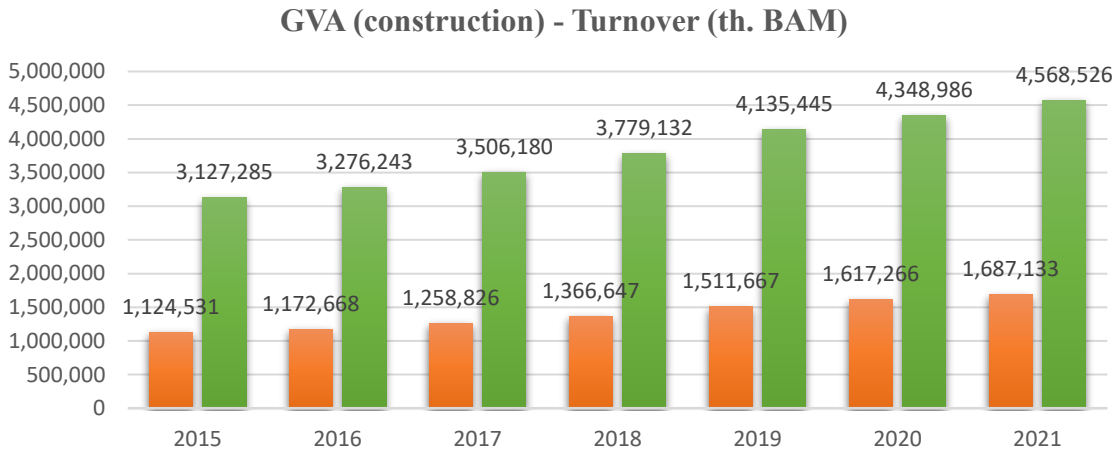

Figure 4. Graphic representation of gross added value (construction) and turnover in thousand. BAM from 2015-2021

Figure 5. Graphical representation of the expansion of construction companies for the period 2015-2021

b5) Gross Value Added/GDP; r=0.966

This correlation coefficient of 0.966 indicates an exceptionally strong linear relationship between gross value added and GDP. As gross value-added increases, GDP also increases in near-perfect alignment. This near-perfect correlation suggests a causal relationship between these two variables, as gross value added is a component of GDP. GDP is calculated as the sum of the gross value added by all sectors, including agriculture, industry, and services, along with net taxes on products. Therefore, growth in gross value added directly contributes to GDP growth.

b6) Gross Value Added/CPI; r=0.572

The coefficient indicates a moderate positive correlation between gross value added and the Consumer Price Index (CPI). This suggests that, generally, the growth of gross value added somewhat follows the increase in consumer prices, but the relationship is not very strong. Moderate correlation implies that sectors with higher added value may influence consumer price growth, but this influence is not direct or automatic. Various factors such as external shocks, changes in import prices, or monetary policy may mediate the connection between value creation in the economy and price movements, making the correlation relatively lower compared to other macroeconomic indicators.

b7) Gross Value Added/Unemployment; r=-0.952

The coefficient between gross value added (GVA) and the unemployment rate indicates a very strong negative correlation between these two variables. This high negative correlation suggests that as gross value-added increases, the unemployment rate significantly decreases. In practice, sectors that generate more value in the economy contribute to job creation and reduce unemployment. When companies or industries increase their value added, it usually reflects business growth, higher productivity, and increased employment, which directly reduces the number of unemployed. This strong connection can be explained by the fact that sectors with higher added value are key drivers of economic growth, which leads to higher labor demand.

b8) Gross Value Added/Basel AML Index (2015-2020); r=0.347

The coefficient between gross value added (GVA) and the Basel AML Index indicates a weak positive correlation between these variables. The Basel AML Index measures the risk of money laundering and terrorist financing. This result suggests that, while there is some connection between the growth of gross value added and an increased risk of money laundering, the relationship is not strong. A weak correlation could mean that sectors with higher added value may attract more attention due to more complex financial flows, which could increase the risk of illegal activities. However, other factors, such as regulatory frameworks, political stability, and the transparency of the financial system, have a much greater impact on the Basel AML Index, explaining the relatively low correlation. Therefore, while there is some connection between GVA and money laundering risk, it is not strong enough to suggest a direct dependence.

11. Discussion

In the correlation analysis between different economic variables and suspicious transactions, we notice the following:

- **Suspicious Transactions and GDP**: A correlation of **r=−0.403** suggests a weak negative relationship, which may indicate that an increase in GDP could lead to a reduction in suspicious transactions. This connection suggests that a stronger economy results in better mechanisms for monitoring and reporting suspicious activities.

- **Suspicious Transactions and CPI**: A correlation of **r=−0.594** shows a stronger negative connection, suggesting that high inflation may reduce the number of suspicious transactions. This result could be due to increased pressure on consumers, prompting them to avoid suspicious financial activities.

- **Suspicious Transactions and Unemployment**: With a correlation of **r=−0.032**, we see a very weak negative link. This weak correlation suggests that the unemployment rate is not significantly related to the number of suspicious transactions, implying that suspicious activities do not directly depend on the labor market.

- **Suspicious Transactions and Basel AML Index**: A correlation of **r=0.167** indicates a very weak positive relationship. This suggests that while there is some connection between the risk of money laundering and suspicious transactions, it is not significant.

- **Cash Transaction Reports and GDP**: With **r=0.565**, there is a moderate positive correlation, indicating that GDP growth leads to an increase in the number of cash transaction reports.

- **Cash Transaction Reports and CPI**: A correlation of **r=0.310** shows a weaker positive relationship, suggesting that inflation may influence cash transaction reporting, but not in a significant way.

- **Cash Transaction Reports and Unemployment**: A correlation of **r=−0.544** suggests a negative relationship, meaning that a rise in unemployment may reduce the number of cash transaction reports, possibly due to a decline in economic activity.

- **Cash Transaction Reports and Basel AML Index**: With **r=0.861**, there is a strong positive correlation, suggesting that a higher risk of money laundering leads to an increase in cash transaction reports.

- **Value of Construction Works and GDP**: A correlation of **r=0.868** indicates a strong positive relationship, meaning that GDP growth leads to an increase in the value of completed construction works.

- **Value of Construction Works and CPI**: With **r=0.799**, there is a significant positive correlation, suggesting that inflation also impacts the growth of construction works' value.

- **Value of Construction Works and Unemployment**: A correlation of **r=−0.71** suggests that higher unemployment negatively affects the value of construction works, which may be a result of reduced investment in the construction sector.

- **Value of Construction Works and Basel AML Index**: A correlation of **r=−0.214** indicates a weak negative connection, suggesting that sectors with a higher risk of money laundering may not be as active in construction projects.

- **Gross Value Added and GDP**: With **r=0.966**, there is a very strong positive correlation, indicating that an increase in gross value added directly influences GDP growth.

- **Gross Value Added and CPI**: A correlation of **r=0.572** shows a moderate positive relationship, suggesting that inflation impacts gross value added.

- **Gross Value Added and Unemployment**: With **r=−0.952**, we see a very strong negative relationship, suggesting that higher unemployment reduces gross value added and, consequently, overall economic growth.

- **Gross Value Added and Basel AML Index**: A correlation of **r=0.347** indicates a weak positive relationship, meaning that an increase in gross value added

may be somewhat connected with a reduction in the risk of money laundering, but not significantly.

In short, the results of the analysis point to complex relationships between economic variables and suspicious transactions. A stronger GDP, higher gross value added, and lower unemployment are often linked to a reduction in suspicious transactions. However, there are variables that show weaker or unclear correlations, suggesting the need for further research and analysis of the factors influencing money laundering and economic activities.

12. Analysis of outliers

In the previously presented tables that display the values of relevant variables over the past years, certain outliers appear in the following categories: the volume and total value of reported suspicious transactions (2017, 2018, 2021, 2022), cash transactions (2017, 2022), the value of completed construction works (2022), and the number of construction companies and their turnover (2019, 2021).

Between 2019 and 2020, 202 new construction companies were opened, and between 2020 and 2021, 616 new construction companies were established. The value of construction works increased by 308,147,000 BAM between 2021 and 2022. The total value of suspicious transactions increased by 88,632,452.3 BAM between 2017 and 2018, and by 131,054,362 BAM between 2021 and 2022.

It is worth noting that, in view of the values characterized as extreme, during these periods, the budgets of Bosnia and Herzegovina were damaged by tens of millions of BAM (due to the inability to precisely quantify and identify the causes, this remains a scientific theory).

13. Conclusion

This analysis of the correlation between economic variables and suspicious transactions provides a clearer picture of their connections and significance. The results show that there are significant positive and negative correlations between suspicious transactions, GDP, inflation, unemployment, and other relevant variables.

Key findings produced by this research include:

• Lack of a unified national database.

• Weak oversight and the absence of databases, such as a register of beneficial owners.

• High opacity of data, which leads to an unclear picture and could be one of the reasons why Bosnia and Herzegovina has been absent from the Basel AML Institute lists for years, which is certainly a significant oversight.

• Sharp increases in the reporting of suspicious transactions and their total value, which more than doubled in the periods 2017-2018 and 2021-2022.

• Strong positive correlations between:

- the number of cash transaction reports and the Basel AML Index,
- the value of completed construction works and GDP,
- construction works and the Consumer Price Index (CPI),
- gross added value and GDP. • Significant increase in the reporting of cash transactions and their total value in the period 2015-2017 and 2021-2022. • Unusual increase in the total value of construction works in the period 2021-2022, by as much

as 308,147,000 BAM, representing an 18.11% increase. • Expansion in construction, with 818 new construction companies opening between 2019 and 2021.

Considering that money laundering is a complex issue, further research is needed to better understand the mechanisms affecting these relationships. Additionally, the implementation of more effective anti-money laundering measures and strengthening institutions can help reduce suspicious transactions and improve overall economic stability. Technological advancement in sectors responsible for combating this phenomenon is absolutely necessary. Better cooperation at all levels and the creation of a unified database are needed to ensure the transparency and ease of tracking information flow, updates, and the establishment of outliers. These studies can serve as a basis for decision-making and strategies to improve, introduce new legal regulations, and build both economic and technological infrastructure in Bosnia and Herzegovina to combat this phenomenon.

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References

Agency for Statistics of Bosnia and Herzegovina. Available at https://bhas.gov.ba/.

Basel Institute on Governance. Available at https://baselgovernance.org/.

Brent L. Bartlett (May 2002). The negative effects of money laundering on economic development. Available at https://waleolusi.wordpress.com/wpcontent/uploads/2013/05/the-negative-effects-of-money-laundering-on-econom.pdf.

Budimir, N. (2020). *Pranje novca kao savremeni fenomen – pojam, faze i sprečavanje pranja novca* [Money laundering as a modern phenomenon – concept, stages and prevention of money laundering]. Državni univerzitet u Novom Pazaru. Available at https://www.dunp.np.ac.rs/lat/wp-content/uploads/2022/publikacije/serija-b/2020vol3/br1/6.pdf.

The Financial Intelligence Unit (FOO) of the State Investigation and Protection Agency (SIPA). Available at http://www.sipa.gov.ba/bs/o-nama/struktura/organizaciona-struktura/finansijskoobavjestajni-odjel.

Iljkić, D. (2015). Pranje novca u domaćem i stranom zakonodavstvu [Money laundering in domestic and foreign legislation]. Available at https://hrcak.srce.hr/156025.

Jun Tang Lishan Ai (2010). Combating money laundering in transition countries: the inherent limitations and practical issues. *Journal of Money Laundering Control*, Vol. 13 Iss 3 pp. 215-225. Available at https://ideas.repec.org/a/eme/jmlcpp/13685201011057127.html.

Lalić, J., Nović, S., & Ubiparipović, S. (2022). Pranje novca [Money laundering]. *Defendologija*. Available at https://defendologija-banjaluka.com/files/Defendologija%2051-52%20srpski%20web.pdf.

Raković, M. (D.) (2009). Pranje novca: kako ga iskorijeniti? [Money laundering: how to eradicate it?] Pravni fakultet Banja Luka Available at https://hrcak.srce.hr/35365.

Strategija i akcioni plan za sprečavanje pranja novca i finansiranja terorističkih aktivnosti u Bosni i Hercegovini [Strategy and Action plan for the prevention of money laundering and financing of terrorist activities in Bosnia and Herzegovina]. Ministarstvo sigurnosti Bosne i Hercegovine. Available at https://msb.gov.ba/docs/strategija3.pdf.


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Comparative Analysis Between Cost and Bureaucracy – Sensitivity Method

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Abstract

This paper is about the comparison of cost and bureaucracy in the tax system. The results show that the bureaucracy decreases the tax revenue and the same result is with the costs. The applied methodology is based on the S.M. (Sensitivity Method) where the comparison between the cost and the bureaucracy happens through graphical analysis. The mathematical background and the theory of the money cycle specify the behavior of these variables. The objective of this work is to reveal the interaction between these variables. The scope of the paper is to confirm the behavior of the theory of the Cycle of Money considering these variables.

Keywords: cycle of money, sensitivity method, cost, bureaucracy.

1. Introduction

The money cycle counteracts the variables of the bureaucracy and the cost. The quantification analysis of the sensitivity of the tax system to the cost and bureaucracy is done by the application of the S.M. (Sensitivity Method) (Bergh, 2009; Bourdin & Nadou, 2018; Challoumis, 2020d, 2020a, 2021d; Corti et al., 2020; Ginsburgh & Weber, 2020; Levi, 2021; Ortun et al., 2017; Paes-Sousa et al., 2019; Rumayya et al., 2020; Tvaronavičienė et al., 2018; Urwannachotima et al., 2020; Woody & Viney, 2017; Παπακωνσταντίνου et al., 2013). The background of this method stands on the behavior analysis of mathematical equations. According to bibliography (Challoumis, 2018a, 2018b, 2023g, 2023b, 2023a, 2023i, 2023c, 2023j, 2023k, 2023d, 2023l, 2023e, 2020a, 2023m, 2023o, 2024b, 2024c, 2024a, 2020b, 2021b, 2021a, 2022a, 2022b, 2023h, 2023f). The cycle of money is the theory where the Q.E. method and also the Sensitivity method have been applied (Aitken, 2019; Arai et al., 2018; Biernaski & Silva, 2018; Buonomo et al., 2020; Challoumis, 2018c; Diallo et al., 2021; Fernandez & Raine, 2019; Hasselman & Stoker, 2017; Hyeon Sik Seo & YoungJun Kim, 2020; Kananen, 2012; Khadzhyradieva et al., 2019; Kroth et al., 2020; Leckel et al., 2020; Loayza & Pennings, 2020; Montenegro Martínez et al., 2020; Nielsen et al., 2019; Ruiz et al., 2017; Scholvin & Malamud, 2020; Soboleva I.V., 2019; Syukur, 2020; Taub, 2015; Ustinovich & Kulikov,

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2020; Watanabe et al., 2018). The Sensitivity Method is based on the concept of how sensitive is a variable. To achieve this there are two steps:

- It should be defined as the equation that is under examination, according to the applied theory.
- Following the same concept of the Q.E. method it is the case that one variable is there in the one case, and the other case is omitted. The basic difference between the Sensitivity Method to the Q.E. method is that Sensitivity does not use the generator, to produce random values, but there is each time a condition that should be satisfied.

The S.M. (Sensitivity Method) is plausible to be applied using a combination of mathematics and programming (Challoumis, 2018c, 2021i, 2022c, 2023p, 2023n, 2023q, 2023r, 2023u, 2023t, 2023s, 2024e, 2024d, 2021j, 2021e, 2021c, 2021d, 2021g, 2021h, 2021f, 2022d; Challoumis & Savic, 2024). The quantification of quality data is the concept of the S.M. (the same happens with the Q.E. method, but from a different point of view (Aakre & Rübbelke, 2010; Baker et al., 2020; Blundell & Preston, 2019; Bowling et al., 2019; Brownell & Frieden, 2009; J. N. B. Campos, 2015; Carattini et al., 2018; Díaz et al., 2020; Fan et al., 2020; Fronzaglia et al., 2019; Gocekli & Comertler, 2021; Grabs et al., 2020; Hai, 2016; Liu et al., 2018; Maestre-Andrés et al., 2019; Marques, 2019; OECD, 2017, 2020; Persson & Tinghög, 2020; Silva et al., 2020; TUTER, 2020; Wright et al., 2017).” Then, it is plausible to quantify quality data. In our analysis, this method is used for clarification of the behavior of the impact factor of the global tax revenue.

2. Literature review

The impact factor of tax revenues of countries which are tax heaves, s according to the bibliography (Challoumis, 2018c, 2021j, 2022c, 2023p, 2023n, 2023q, 2023r, 2023u, 2023t, 2023s, 2024e, 2024d, 2021c, 2024f, 2024g, 2021e, 2021i, 2021d, 2021g, 2021h, 2021f, 2022d; Challoumis & Savic, 2024). It is determined as that:

$$s = \frac{k+l}{r+c+t+i} \quad (1)$$

“Therefore, are countries that receive the products that are taxed in different countries. This allocation of profits between profits and losses permits the enterprises that participate in controlled transactions of the transfer pricing activities to maximize their utility. But, contemporaneously the tax revenue from a global view has declined. Then, the loss of tax income from some countries is more than the profits that make the countries which are tax havens. Thereupon, the symbol of s the impact factor of tax revenue from a global view, and there are some coefficients which are $k, l, r, t,$ and c. Thus, the symbol of k is about the impact factor of capital, l is the impact factor about the liability of the authorities on the tax system. The interpretation of the liability is about how unbalanced it is the tax system. The parameter of r is about the risk, the t is about how much trustworthy is the tax system from the view of cost (Arabyan, 2016; Arbel et al., 2019; Camous & Gimber, 2018; J. Campos et al., 2019; Chubarova et al., 2020; de A. Dantas et al., 2018; de Vasconcelos et al., 2019; Farah, 2011; Goldsztejn et al., 2020b, 2020a; Hartz & John, 2009; Herrington, 2015; Islam et al., 2020; Jia et al., 2020; Kartini et al., 2019; Lajas & Macário, 2020; Martinez & Rodríguez, 2020; Marume, 2016; Nash et al., 2017;

Noland, 2020; Peres et al., 2020; Torres & Riaño-Casallas, 2018; Tummers, 2019). The i is about the requirements of the intangibles (different relation from the intangibles which are proportional to capital). The symbols with the "~" are accordingly the same thing but from the view of the uncontrolled transactions. Thus, the numerator is proportional to the income of taxes, as the investments and the stable tax environments, with a lack of cost enhance the tax income (Acs et al., 2016; Adhikari et al., 2006; Andriansyah et al., 2019; Kanthak & Spies, 2018; Korenik & Wegrzyn, 2020; Kreft & Sobel, 2005; Ladvocat & Lucas, 2019; Nayak, 2019; Ud Din et al., 2016). On the other hand, the denominator is inverting proportional to the tax income, as the risk, the cost, and the unbalance of taxation cause less tax income. Moreover, for $\tilde{s}$:

$$\tilde{s} = \frac{\tilde{k}+\tilde{l}}{\tilde{r}+\tilde{c}+\tilde{t}+\tilde{i}} \quad (2)$$

It is determined the aggregate impact factor of tax revenues, which is symbolized by $\hat{s}$, and is defined by the next equation:

$$\hat{s} = s + \tilde{s} \quad (3)$$

Based on the prior equations it is plausible to proceed to the identification of the behavior of the impact factors of tax revenues in the case of tax heavens and the case of the non-tax heavens. Then, s is a factor that allows the comparison between the controlled with the uncontrolled transactions. Thence is plausible to have a standalone behavior analysis of controlled transactions and a combined behavior analysis between the controlled transactions with the uncontrolled transactions. The next section analyzes the impact factor of tax revenues with the rest impact factors."

This methodology is illustrated below:

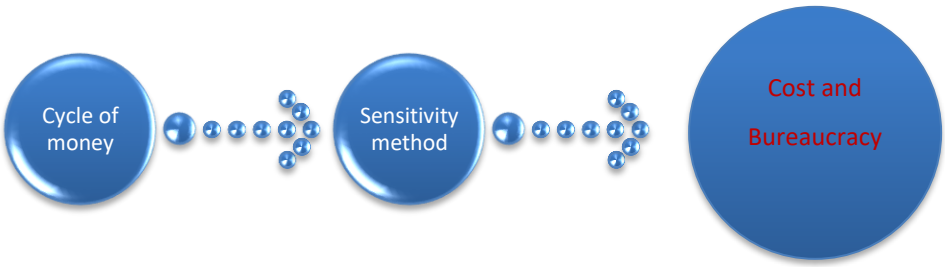

Figure 1. S.M. (Sensitivity Method)

The previous scheme followed the Sensitivity Method to determine the behavior of the global tax revenue in the case that the existence of the cost and the ideal case that this factor is avoided.

3. Results

The cost is in interaction with the impact factor of tax revenues. In this behavioral analysis is determined the model which clarifies the behavior of the impact factor of tax revenues with the existence and with the avoidance of the impact factor of tax sensibility (Challoumis, 2018e, 2018d, 2022e, 2023y, 2023x, 2023w, 2023v, 2023z, 2024h, 2024l, 2024m, 2024j, 2019e, 2024k, 2019a, 2019d, 2019c, 2019b, 2020d, 2020c, 2021k). Then, for the application of the Sensitivity Method:

$$t > l > i > r > k > c \quad (4)$$

Therefore, it is plausible to proceed to a quantity analysis using equations (1), (2), and (4). Therefore, applying the Sensitivity method and choosing the appropriate magnitudes for the coefficient:

Table 1. Compiling coefficients

Factors	Values of s	Values of s'
k	0,4	0,4
i	0.6	0.6
l	0.7	0.7
r	0.5	0.5
c	0.3	-
t	0.8	-
fs	<0.3	<0.3
f_i	<0.3	<0.3

The prior table presents the data that are under examination to be able to compile the model and confirm that the impact factor of cost declines the tax revenue (Challoumis, 2018e, 2018f, 2020d, 2020c, 2021k, 2023v, 2023y, 2023x, 2023aa, 2023ab, 2023ah, 2023ad, 2018d, 2023w, 2023z, 2023ae, 2023af, 2023ag, 2023ac, 2024m, 2024k, 2024h, 2024j, 2019b, 2024l, 2024n, 20240, 2024p, 2019f, 2019d, 2019e, 2019a, 2019g, 2019c).

Therefore, using the Sensitivity Method:

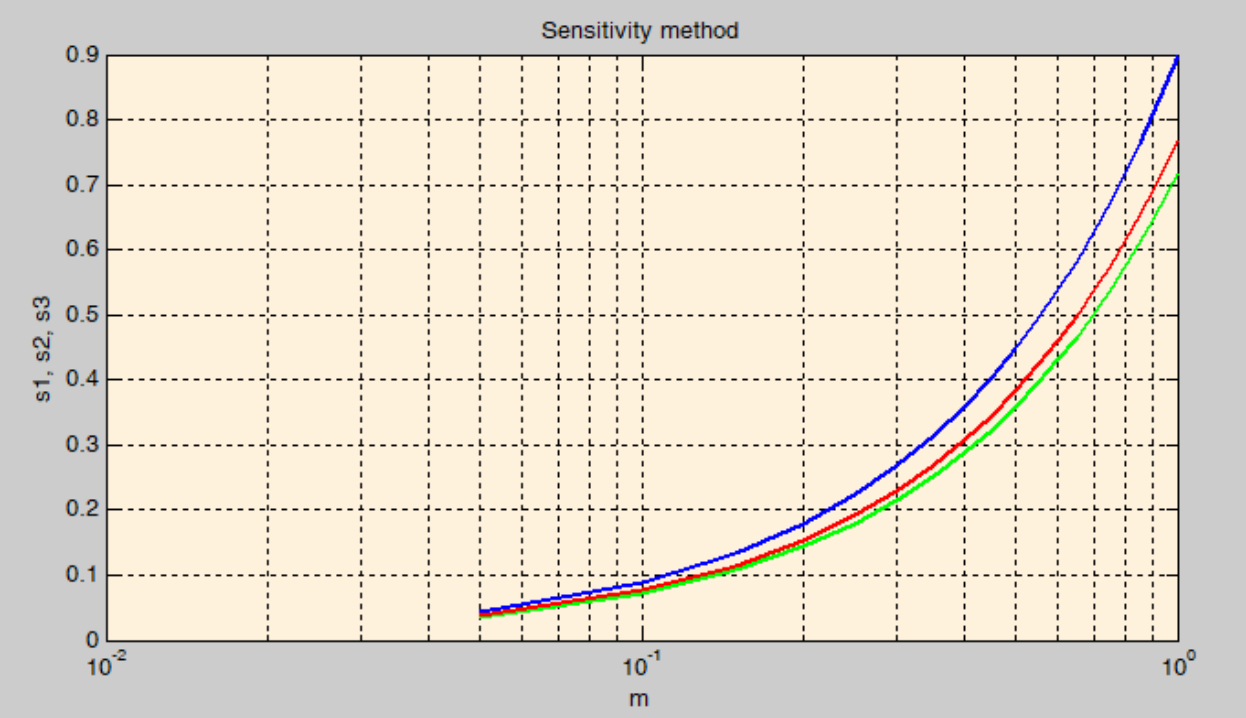

Figure 3. Application of S.M.

In logarithmic forms, the red line is about the case that there doesn't exist cost, and the blue line is the case that there does exist bureaucracy. The green line is the case

that there are all the variables. It is confirmed by the theoretical background of the theory of the money cycle (or the theory of the cycle of money).

4. Conclusions

This paper examined the case of cost and bureaucracy and how interact with global tax revenue. Then the companies that participate in controlled transactions prefer as expected the tax environments that have unstable law rules and insecure economies. This has an impact on the companies that participate in controlled transactions to be increased in numbers because that way can allocate their profits and losses better. Then, the decrease in cost could rapidly increase the tax revenue. Simultaneously the decrease of bureaucracy increases the tax revenue. Then, the decrease in bureaucracy and cost leads to an ideal case for the money cycle.

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References

Aakre, S., & Rübbelke, D. T. G. (2010). Objectives of public economic policy and the adaptation to climate change. *Journal of Environmental Planning and Management*, *53*(6). https://doi.org/10.1080/09640568.2010.488116

Acs, Z., Åstebro, T., Audretsch, D., & Robinson, D. T. (2016). Public policy to promote entrepreneurship: a call to arms. *Small Business Economics*, *47*(1). https://doi.org/10.1007/s11187-016-9712-2

Adhikari, A., Derashid, C., & Zhang, H. (2006). Public policy, political connections, and effective tax rates: Longitudinal evidence from Malaysia. *Journal of Accounting and Public Policy*, *25*(5). https://doi.org/10.1016/j.jaccpubpol.2006.07.001

Aitken, A. (2019). Measuring Welfare Beyond GDP. *National Institute Economic Review*, *249*(1). https://doi.org/10.1177/002795011924900110

Andriansyah, A., Taufiqurokhman, T., & Wekke, I. S. (2019). Responsiveness of public policy and its impact on education management: An empirical assessment from Indonesia. *Management Science Letters*, *9*(3). https://doi.org/10.5267/j.msl.2018.12.008

Arabyan, O. (2016). Public infrastructure policies and economic geography. *Glasnik Srpskog Geografskog Drustva / Bulletin of the Serbian Geographical Society*, *96*(1). https://doi.org/10.2298/gsgd1601093a

Arai, R., Naito, K., & Ono, T. (2018). Intergenerational policies, public debt, and economic growth: A politico-economic analysis. *Journal of Public Economics*, *166*. https://doi.org/10.1016/j.jpubeco.2018.08.006

Arbel, Y., Fialkoff, C., & Kerner, A. (2019). Public policy for reducing tax evasion: implications of the Yule–Simpson paradox. *Applied Economics Letters*, *26*(13). https://doi.org/10.1080/13504851.2018.1537471

Baker, S. D., Hollifield, B., & Osambela, E. (2020). Preventing controversial catastrophes. *Review of Asset Pricing Studies*, *10*(1). https://doi.org/10.1093/RAPSTU/RAZ001

Bergh, J. C. J. M. va. den. (2009). The GDP paradox. *Journal of Economic Psychology*, *30*(2). https://doi.org/10.1016/j.joep.2008.12.001

Biernaski, I., & Silva, C. L. (2018). Main variables of Brazilian public policies on biomass use and energy. *Brazilian Archives of Biology and Technology*, *61*(Specialissue). https://doi.org/10.1590/1678-4324-smart-2018000310

Blundell, R., & Preston, I. (2019). Principles of Tax Design, Public Policy and Beyond: The Ideas of James Mirrlees, 1936–2018. *Fiscal Studies*, *40*(1). https://doi.org/10.1111/1475-5890.12183

Bourdin, S., & Nadou, F. (2018). French tech: A new form of territorial mobilization to face up to global competition? *Annales de Geographie*, *2018*(723–724). https://doi.org/10.3917/ag.723.0612

Bowling, S. J., Boyland, L. G., & Kirkeby, K. M. (2019). Property Tax Cap Policy in Indiana and Implications for Public School Funding Equity. *International Journal of Education Policy and Leadership*, *15*(9). https://doi.org/10.22230/ijepl.2019v15n9a881

Brownell, K. D., & Frieden, T. R. (2009). Ounces of Prevention — The Public Policy Case for Taxes on Sugared Beverages. *New England Journal of Medicine*, *360*(18). https://doi.org/10.1056/nejmp0902392

Buonomo, I., Benevene, P., Barbieri, B., & Cortini, M. (2020). Intangible Assets and Performance in Nonprofit Organizations:A Systematic Literature Review. *Frontiers in Psychology*, *11*. https://doi.org/https://doi.org/10.3389/fpsyg.2020.00729

Camous, A., & Gimber, A. R. (2018). Public debt and fiscal policy traps. *Journal of Economic Dynamics and Control*, *93*. https://doi.org/10.1016/j.jedc.2018.02.009

Campos, J., Braga, V., & Correia, A. (2019). Public policies for entrepreneurship and internationalization: Is there a government reputation effect? *Journal of Science and Technology Policy Management*, *10*(4). https://doi.org/10.1108/JSTPM-04-2018-0044

Campos, J. N. B. (2015). Paradigms and Public Policies on Drought in Northeast Brazil: A Historical Perspective. *Environmental Management*, *55*(5). https://doi.org/10.1007/s00267-015-0444-x

Carattini, S., Carvalho, M., & Fankhauser, S. (2018). Overcoming public resistance to carbon taxes. In *Wiley Interdisciplinary Reviews: Climate Change* (Vol. 9, Issue 5). https://doi.org/10.1002/wcc.531

Challoumis, C. (2018a). Analysis of the velocities of escaped savings with that of financial liquidity. *Ekonomski Signali*, *13*(2), 1–14. https://doi.org/10.5937/ekonsig1802001c

Challoumis, C. (2018b). Identification of Significant Economic Risks to the International Controlled Transactions. *Economics and Applied Informatics*, *2018*(3), 149–153. https://doi.org/https://doi.org/10.26397/eai1584040927

Challoumis, C. (2018c). Methods of Controlled Transactions and the Behavior of Companies According to the Public and Tax Policy. *Economics*, *6*(1), 33–43. https://doi.org/10.2478/eoik-2018-0003

Challoumis, C. (2018d). THE IMPACT FACTOR OF HEALTH ON THE ECONOMY USING THE CYCLE OF MONEY. *Bulletin of the Transilvania University of Braşov*, *11*(60), 125–136. https://webbut.unitbv.ro/index.php/Series_V/article/view/2533/1979

Challoumis, C. (2018e). The Keynesian Theory and the Theory of Cycle of Money. *Hyperion Economic Journal*, *6*(3), 3–8. https://hej.hyperion.ro/articles/3(6)_2018/HEJnr3(6)_2018_A1Challoumis.pdf.

Challoumis, C. (2018f). The Role of Risk to the International Controlled Transactions. *Economics and Applied Informatics*, *2018*(3), 57–64. https://doi.org/10.26397/eai1584040917

Challoumis, C. (2019a). The arm's length principle and the fixed length principle economic analysis. *World Scientific News*, *115*(2019), 207–217. http://www.worldscientificnews.com/wp-content/uploads/2018/11/WSN-115-2019-207-217.pdf.

Challoumis, C. (2019b). The cycle of money with and without the escaped savings. *Ekonomski Signali*, *14*(1), 89–99. https://doi.org/336.76 336.741.236.5

Challoumis, C. (2019c). The Impact Factor of Education on the Public Sector and International Controlled Transactions. *Complex System Research Centre*, *2019*, 151–160. https://www.researchgate.net/publication/350453451_The_Impact_Factor_of_Education_on_the_Public_Sector_and_International_Controlled_Transactions.

Challoumis, C. (2019d). The Issue of Utility of Cycle of Money. *Journal Association SEPIKE*, *2019*(25), 12–21. https://5b925ea6-3d4e-400b-b5f3-32dc681218ff.filesusr.com/ugd/b199e2_dd29716b8bec48ca8fe7fbcfd47cdd2e.pdf.

Challoumis, C. (2019e). The R.B.Q. (Rational, Behavioral and Quantified) Model. *Ekonomika*, *98*(1), 6–18. https://doi.org/10.15388/ekon.2019.1.1

Challoumis, C. (2019f). Theoretical analysis of fuzzy logic and Q. E. method in economics. *IKBFU's Vestnik*, *2019*(01), 59–68.

Challoumis, C. (2019g). Transfer Pricing Methods for Services and the Policy of Fixed Length Principle. *Economics and Business*, *33*(1), 222–232. https://doi.org/https://doi.org/10.2478/eb-2019-0016

Challoumis, C. (2020a). Analysis of the Theory of Cycle of Money. *Acta Universitatis Bohemiae Meridionalis*, *23*(2), 13–29. https://doi.org/https://doi.org/10.2478/acta-2020-0004

Challoumis, C. (2020b). Impact Factor of Capital to the Economy and Tax System. *Complex System Research Centre*, *2020*, 195–200. https://www.researchgate.net/publication/350385990_Impact_Factor_of_Capital_to_the_Economy_and_Tax_System.

Challoumis, C. (2020c). The Impact Factor of Costs to the Tax System. *Journal of Entrepreneurship, Business and Economics*, *8*(1), 1–14. http://scientificia.com/index.php/JEBE/article/view/126.

Challoumis, C. (2020d). The Impact Factor of Education on the Public Sector – The Case of the U.S. *International Journal of Business and Economic Sciences Applied Research*, *13*(1), 69–78. https://doi.org/10.25103/ijbesar.131.07

Challoumis, C. (2021a). Chain of cycle of money. *Acta Universitatis Bohemiae Meridionalis*, *24*(2), 49–74.

Challoumis, C. (2021b). Index of the cycle of money - The case of Belarus. *Economy and Banks*, *2*.

Challoumis, C. (2021c). Index of the cycle of money - The case of Greece. *IJBESAR (International Journal of Business and Economic Sciences Applied Research)*, *14*(2), 58–67.

Challoumis, C. (2021d). Index of the Cycle of Money - The Case of Latvia. *Economics and Culture*, *17*(2), 5–12. https://doi.org/10.2478/jec-2020-0015

Challoumis, C. (2021e). Index of the cycle of money - The case of Montenegro. *Montenegrin Journal for Social Sciences*, *5*(1–2), 41–57.

Challoumis, C. (2021f). Index of the cycle of money - The case of Serbia. *Open Journal for Research in Economics (OJRE)*, *4*(1). https://centerprode.com/ojre.html

Challoumis, C. (2021g). Index of the cycle of money - The case of Slovakia. *S T U D I A C O M M E R C I A L I A B R A T I S L A V E N S I A Ekonomická Univerzita v Bratislave*, *14*(49), 176–188.

Challoumis, C. (2021h). Index of the cycle of money - The case of Thailand. *Chiang Mai University Journal of Economics*, *25*(2), 1–14. https://so01.tci-thaijo.org/index.php/CMJE/article/view/247774/169340.

Challoumis, C. (2021i). Index of the cycle of money - The case of Ukraine. *Actual Problems of Economics*, *243*(9), 102–111. https://doi.org/10.32752/1993-6788-2021-1-243-244-102-111

Challoumis, C. (2021j). Index of the cycle of money -the case of Bulgaria. *Economic Alternatives*, *27*(2), 225–234. https://www.unwe.bg/doi/eajournal/2021.2/EA.2021.2.04.pdf.

Challoumis, C. (2021k). The cycle of money with and without the enforcement savings. *Complex System Research Centre*.

Challoumis, C. (2022a). Conditions of the CM (Cycle of Money). In *Social and Economic Studies within the Framework of Emerging Global Developments, Volume -1, V. Kaya* (pp. 13–24). https://doi.org/10.3726/b19907

Challoumis, C. (2022b). Impact Factor of the Rest Rewarding Taxes. In *Complex System Research Centre*. https://doi.org/10.2139/ssrn.3154753

Challoumis, C. (2022c). Index of the cycle of money - The case of Moldova. *Eastern European Journal of Regional Economics*, *8*(1), 77–89.

Challoumis, C. (2022d). Index of the cycle of money - the case of Poland. *Research Papers in Economics and Finance*, *6*(1), 72–86. https://journals.ue.poznan.pl/REF/article/view/126/83.

Challoumis, C. (2022e). Structure of the economy. *Actual Problems of Economics*, *247*(1).

Challoumis, C. (2023a). A comparison of the velocities of minimum escaped savings and financial liquidity. In *Social and Economic Studies within the Framework of Emerging Global Developments, Volume - 4, V. Kaya* (pp. 41–56). https://doi.org/10.3726/b21202

Challoumis, C. (2023b). Capital and Risk in the Tax System. In *Complex System Research Centre* (pp. 241–244).

Challoumis, C. (2023c). Chain of the Cycle of Money with and without Maximum and Minimum Mixed Savings. *European Multidisciplinary Journal of Modern Science*, *23*(2023), 1–16.

Challoumis, C. (2023d). Chain of the Cycle of Money with and Without Maximum Mixed Savings (Three-Dimensional Approach). *Academic Journal of Digital Economics and Stability*, *34*(2023), 43–65.

Challoumis, C. (2023e). Chain of the Cycle of Money with and without Minimum Mixed Savings (Three-Dimensional Approach). *International Journal of Culture and Modernity*, *33*(2023), 22–33.

Challoumis, C. (2023f). Comparisons of the Cycle of Money Based on Enforcement and Escaped Savings. *Pindus Journal of Culture, Literature, and ELT*, *3*(10), 19–28.

Challoumis, C. (2023g). Comparisons of the cycle of money with and without the mixed savings. *Economics & Law*. http://el.swu.bg/ikonomika/.

Challoumis, C. (2023h). Currency rate of the CM (Cycle of Money). *Research Papers in Economics and Finance*, *7*(1).

Challoumis, C. (2023i). Elements of the Theory of Cycle of Money without Enforcement Savings. *International Journal of Finance and Business Management (IJFBM)Vol. 2No. 1, 2023*, *2*(1), 15–28. https://journal.multitechpublisher.com/index.php/ijfbm/article/view/1108/1202.

Challoumis, C. (2023j). FROM SAVINGS TO ESCAPE AND ENFORCEMENT SAVINGS. *Cogito*, *XV*(4), 206–216.

Challoumis, C. (2023k). G7 - Global Minimum Corporate Tax Rate of 15%. *International Journal of Multicultural and Multireligious Understanding (IJMMU)*, *10*(7).

Challoumis, C. (2023l). Impact factor of cost to the tax system. *Ekonomski Signali*, *18*(2), 12.

Challoumis, C. (2023m). Impact Factor of Liability of Tax System According to the Theory of Cycle of Money. In *Social and Economic Studies within the Framework of Emerging Global Developments Volume 3, V. Kaya* (Vol. 3, pp. 31–42). https://doi.org/10.3726/b20968

Challoumis, C. (2023n). Index of the cycle of money: The case of Costa Rica. *Sapienza*, *4*(3), 1–11. https://journals.sapienzaeditorial.com/index.php/SIJIS.

Challoumis, C. (2023o). Index of the cycle of money - The case of Canada. *Journal of Entrepreneurship, Business and Economics*, *11*(1), 102–133. http://scientificia.com/index.php/JEBE/article/view/203.

Challoumis, C. (2023p). Index of the Cycle of Money - The Case of England. *British Journal of Humanities and Social Sciences*, *26*(1), 68–77.

Challoumis, C. (2023q). Index of the cyclee of money - The case of Ukraine from 1992 to 2020. *Actual Problems of Economics*.

Challoumis, C. (2023r). Maximum mixed savings on the cycle of money. *Open Journal for Research in Economics*, *6*(1), 25–34.

Challoumis, C. (2023s). Minimum Mixed Savings on Cycle of Money. *Open Journal for Research in Economics*, *6*(2), 61–68. https://centerprode.com/ojre/ojre0602/ojre-0602.html.

Challoumis, C. (2023t). Multiple Axiomatics Method and the Fuzzy Logic. *MIDDLE EUROPEAN SCIENTIFIC BULLETIN*, *37*(1), 63–68.

Challoumis, C. (2023u). Principles for the Authorities on Activities with Controlled Transactions. *Academic Journal of Digital Economics and Stability*, *30*(1), 136–152.

Challoumis, C. (2023v). The Cycle of Money (C.M.) Considers Financial Liquidity with Minimum Mixed Savings. *Open Journal for Research in Economics*, *6*(1), 1–12.

Challoumis, C. (2023w). The Cycle of Money with and Without the Maximum and Minimum Mixed Savings. *Middle European Scientific Bulletin*, *41*(2023), 47–56.

Challoumis, C. (2023x). The cycle of money with and without the maximum mixed savings (Two-dimensional approach). *International Journal of Culture and Modernity*, *33*(2023), 34–45.

Challoumis, C. (2023y). The Cycle of Money with and Without the Minimum Mixed Savings. *Pindus Journal of Culture, Literature, and ELT*, *3*(10), 29–39.

Challoumis, C. (2023z). The cycle of money with mixed savings. *Open Journal for Research in Economics*, *6*(2), 41–50.

Challoumis, C. (2023aa). The Theory of Cycle of Money - How Do Principles of the Authorities on Public Policy, Taxes, and Controlled Transactions Affect the Economy and Society? *International Journal of Social Science Research and Review (IJSSRR)*, *6*(8).

Challoumis, C. (2023ab). The Velocities of Maximum Escaped Savings with than of Financial Liquidity to the Case of Mixed Savings. *International Journal on Economics, Finance and Sustainable Development*, *5*(6), 124–133.

Challoumis, C. (2023ac). The Velocity of Escaped Savings and Maximum Financial Liquidity. *Journal of Digital Economics and Stability*, *34*(2023), 55–65.

Challoumis, C. (2023ad). The Velocity of Escaped Savings and Velocity of Financial Liquidity. *Middle European Scientific Bulletin*, *41*(2023), 57–66.

Challoumis, C. (2023ae). Utility of cycle of money with and without the enforcement savings. *GOSPODARKA INNOWACJE*, *36*(1), 269–277.

Challoumis, C. (2023af). Utility of Cycle of Money with and without the Escaping Savings. *International Journal of Business Diplomacy and Economy*, *2*(6), 92–101.

Challoumis, C. (2023ag). Utility of Cycle of Money without the Escaping Savings (Protection of the Economy). In *Social and Economic Studies within the Framework of Emerging Global Developments Volume 2, V. Kaya* (pp. 53–64). https://doi.org/10.3726/b20509

Challoumis, C. (2023ah). Velocity of Escaped Savings and Minimum Financial Liquidity According to the Theory of Cycle of Money. *European Multidisciplinary Journal of Modern Science*, *23*(2023), 17–25.

Challoumis, C. (2024a). Approach on arm's length principle and fix length principle mathematical representations. In *Innovations and Contemporary Trends in Business & Economics*.

Challoumis, C. (2024b). Estimations of the cycle of money without escape savings. *International Journal of Multicultural and Multireligious Understanding*, *11*(3).

Challoumis, C. (2024c). Impact Factors of Global Tax Revenue - Theory of Cycle of Money. *International Journal of Multicultural and Multireligious Understanding*, *11*(1).

Challoumis, C. (2024d). Index of the cycle of money – the case of Switzerland. *The Index of the Cycle of Money: The Case of Switzerland. J. Risk Financial Manag. 2024, 17, 135. Https://Doi.Org/10.3390/Jrfm17040135*, *17*(4), 1–24. https://doi.org/https://doi.org/10.3390/jrfm17040135

Challoumis, C. (2024e). Minimum escaped savings and financial liquidity in mathematical representation. *Ekonomski Signali*, *19*(1).

Challoumis, C. (2024f). Rewarding taxes on the cycle of money. In *Social and Economic Studies within the Framework of Emerging Global Developments* (Vol. 5).

Challoumis, C. (2024g). Rewarding taxes on the economy (The theory of cycle of money). *International Journal of Multicultural and Multireligious Understanding (IJMMU)*, *11*(3).

Challoumis, C. (2024h). Synopsis of principles for the authorities and controlled transactions. *Pindus*.

Challoumis, C. (2024i). Synopsis of principles for the authorities and controlled transactions. *SEPIKE*.

Challoumis, C. (2024j). The cycle of money - Escape savings and the minimum financial liquidity. *International Journal of Multicultural and Multireligious Understanding (IJMMU)*, *11*(4).

Challoumis, C. (2024k). The cycle of money - Minimum escape savings and financial liquidity. *International Journal of Multicultural and Multireligious Understanding (IJMMU)*, *11*(5).

Challoumis, C. (2024l). The impact factor of Tangibles and Intangibles of controlled transactions on economic performance. *Economic Alternatives*.

Challoumis, C. (2024m). THE INFLATION ACCORDING TO THE CYCLE OF MONEY (C.M.). *Economic Alternatives*.

Challoumis, C. (2024n). Velocity of the escaped savings and financial liquidity on maximum mixed savings. *Open Journal for Research in Economics*, *7*(1).

Challoumis, C. (2024o). Velocity of the escaped savings and financial liquidity on minimum mixed savings. *Open Journal for Research in Economics*, *7*(2).

Challoumis, C. (2024p). Velocity of the escaped savings and financial liquidity on mixed savings. *Open Journal for Research in Economics*, *7*(2).

Challoumis, C., & Savic, M. (2024). Rational and Behavioral economics. *Ekonomski Signali*, *19*(1).

Chubarova, T., Maly, I., & Nemec, J. (2020). Public policy responses to the spread of COVID-19 as a potential factor determining health results: A comparative study of the Czech Republic, the Russian Federation, and the Slovak Republic. *Central European Journal of Public Policy*, *14*(2). https://doi.org/10.2478/cejpp-2020-0008

Corti, I. N., Roldán, C. D., & Benito, S. M. R. (2020). Fiscal pressure and fraud, predisposition to pay taxes and personal satisfaction in Spain. *Revista Espanola de Investigaciones Sociologicas*, *172*. https://doi.org/10.5477/cis/reis.172.101

de A. Dantas, G., de Castro, N. J., Dias, L., Antunes, C. H., Vardiero, P., Brandão, R., Rosental, R., & Zamboni, L. (2018). Public policies for smart grids in Brazil. *Renewable and Sustainable Energy Reviews*, *92*. https://doi.org/10.1016/j.rser.2018.04.077

de Vasconcelos, F. de A. G., Machado, M. L., de Medeiros, M. A. T., Neves, J. A., Recine, E., & Pasquim, E. M. (2019). Public policies of food and nutrition in Brazil: From Lula to Temer. *Revista de Nutricao*, *32*. https://doi.org/10.1590/1678-9865201932e180161

Diallo, S. Y., Shults, F. L. R., & Wildman, W. J. (2021). Minding morality: ethical artificial societies for public policy modeling. *AI and Society*, *36*(1). https://doi.org/10.1007/s00146-020-01028-5

Díaz, M. L. A., Ordoñez, F. A. R., & Muñoz, R. A. T. (2020). Open innovation and public policies in developing countries. *International Journal for Quality Research*, *14*(3). https://doi.org/10.24874/IJQR14.03-09

Fan, Y., Yang, S., & Jia, P. (2020). Preferential Tax Policies: An Invisible Hand behind Preparedness for Public Health Emergencies. *International Journal of Health Policy and Management*. https://doi.org/10.34172/ijhpm.2020.139

Farah, M. F. S. (2011). Public policy and public administration. *Revista de Administracao Publica*, *45*(3). https://doi.org/10.1590/S0034-76122011000300011

Fernandez, M. A., & Raine, K. D. (2019). Insights on the Influence of Sugar Taxes on Obesity Prevention Efforts. In *Current Nutrition Reports* (Vol. 8, Issue 4). https://doi.org/10.1007/s13668-019-00282-4

Fronzaglia, M. L., de Moura Júnior, Á. A., Racy, J. C., & Vartanian, P. R. (2019). Possible Effects of Economic Public Policies Implemented in Brazil after the Financial Crisis of 2008 on Foreign Direct Investment. *Theoretical Economics Letters*, *09*(08). https://doi.org/10.4236/tel.2019.98176

Ginsburgh, V., & Weber, S. (2020). The Economics of Language. *Journal of Economic Literature*, *58*(2). https://doi.org/10.1257/JEL.20191316

Gocekli, S. G. B., & Comertler, N. (2021). On "The Human" and behavioral economics. *Contemporary Issues with Multidisciplinary Perspectives on Social Science*, 37–47.

Goldsztejn, U., Schwartzman, D., & Nehorai, A. (2020a). Public policy and economic dynamics of COVID-19 spread: A mathematical modeling study. *PLoS ONE*, *15*(12 December). https://doi.org/10.1371/journal.pone.0244174

Goldsztejn, U., Schwartzman, D., & Nehorai, D. A. (2020b). Public policy and economic dynamics of COVID-19 spread: A mathematical modeling study. In *medRxiv*. https://doi.org/10.1101/2020.04.13.20062802

Grabs, J., Auld, G., & Cashore, B. (2020). Private regulation, public policy, and the perils of adverse ontological selection. *Regulation and Governance*. https://doi.org/10.1111/rego.12354

Hai, D. . (2016). Process of Public Policy Formulation in Developing Countries. *Public Policy*, *C*.

Hartz, S., & John, J. (2009). Public health policy decisions on medical innovations: What role can early economic evaluation play? *Health Policy*, *89*(2). https://doi.org/10.1016/j.healthpol.2008.05.011

Hasselman, L., & Stoker, G. (2017). Market-based governance and water management: the limits to economic rationalism in public policy. *Policy Studies*, *38*(5). https://doi.org/10.1080/01442872.2017.1360437

Herrington, C. M. (2015). Public education financing, earnings inequality, and intergenerational mobility. *Review of Economic Dynamics*, *18*(4). https://doi.org/10.1016/j.red.2015.07.006

Hyeon Sik Seo, & YoungJun Kim. (2020). INTANGIBLE ASSETS INVESTMENT AND FIRMS' PERFORMANCE: EVIDENCE FROM SMALL AND MEDIUM-SIZED ENTERPRISES IN KOREA. *Journal of Business Economics and Management*, *21*(2), 421–445.

Islam, A., Rashid, M. H. U., Hossain, S. Z., & Hashmi, R. (2020). Public policies and tax evasion: evidence from SAARC countries. *Heliyon*, *6*(11). https://doi.org/10.1016/j.heliyon.2020.e05449

Jia, M., Liu, Y., Lieske, S. N., & Chen, T. (2020). Public policy change and its impact on urban expansion: An evaluation of 265 cities in China. *Land Use Policy*, *97*. https://doi.org/10.1016/j.landusepol.2020.104754

Kananen, J. (2012). International ideas versus national traditions: Nordic economic and public policy as proposed by the OECD. *Journal of Political Power*, *5*(3). https://doi.org/10.1080/2158379X.2012.735118

Kanthak, L., & Spies, D. C. (2018). Public support for European Union economic policies. *European Union Politics*, *19*(1). https://doi.org/10.1177/1465116517740638

Kartini, D. S., Mulyawan, R., & Muradi, M. (2019). Public Policy Pragmatism on Special Economic Zone in Tanjung Lesung, Pandeglang Regency. *MIMBAR: Jurnal Sosial Dan Pembangunan*, *35*(1). https://doi.org/10.29313/mimbar.v35i1.4283

Khadzhyradieva, S., Hrechko, T., & Smalskys, V. (2019). Institutionalisation of behavioural insights in public policy. In *Public Policy and Administration* (Vol. 18, Issue 3). https://doi.org/10.5755/J01.PPAA.18.3.24726

Korenik, D., & Wegrzyn, M. (2020). Public policy timing in a sustainable approach to shaping public policy. *Sustainability (Switzerland)*, *12*(7). https://doi.org/10.3390/su12072677

Kreft, S. F., & Sobel, R. S. (2005). Public policy, entrepreneurship, and economic freedom. In *Cato Journal* (Vol. 25, Issue 3).

Kroth, D. C., Geremia, D. S., & Mussio, B. R. (2020). National school feeding program: A healthy public policy. *Ciencia e Saude Coletiva*, *25*(10). https://doi.org/10.1590/1413-812320202510.31762018

Ladvocat, M., & Lucas, V. (2019). REGIONAL DISPARITIES, PUBLIC POLICIES AND ECONOMIC GROWTH IN BRAZIL. *Revista Baru - Revista Brasileira de Assuntos Regionais e Urbanos*, *5*(2). https://doi.org/10.18224/baru.v5i2.7687

Lajas, R., & Macário, R. (2020). Public policy framework supporting "mobility-as-a-service" implementation. *Research in Transportation Economics*, *83*. https://doi.org/10.1016/j.retrec.2020.100905

Leckel, A., Veilleux, S., & Dana, L. P. (2020). Local Open Innovation: A means for public policy to increase collaboration for innovation in SMEs. *Technological Forecasting and Social Change*, *153*. https://doi.org/10.1016/j.techfore.2019.119891

Levi, S. (2021). Why hate carbon taxes? Machine learning evidence on the roles of personal responsibility, trust, revenue recycling, and other factors across 23 European countries. *Energy Research and Social Science*, *73*. https://doi.org/10.1016/j.erss.2020.101883

Liu, N., Liu, R., Huang, J., & Chen, L. (2018). Pollution, happiness and willingness to pay taxes: The value effect of public environmental policies. *Problemy Ekorozwoju*, *13*(1).

Loayza, N., & Pennings, S. M. (2020). Macroeconomic Policy in the Time of COVID-19 : A Primer for Developing Countries. *World Bank Research and Policy Briefs*, *147291*.

Maestre-Andrés, S., Drews, S., & van den Bergh, J. (2019). Perceived fairness and public acceptability of carbon pricing: a review of the literature. *Climate Policy*, *19*(9). https://doi.org/10.1080/14693062.2019.1639490

Marques, E. C. L. (2019). Notes on networks, the state, and public policies. *Cadernos de Saude Publica*, *35*. https://doi.org/10.1590/0102-311x00002318

Martinez, M. C. V., & Rodríguez, M. C. M. (2020). Public policies of electronic governance and corruption in Mexico. *Public Policy and Administration*, *19*(3). https://doi.org/10.5755/J01.PPAA.19.3.27769

Marume, S. B. M. (2016). Public Policy and Factors Influencing Public Policy. *International Journal of Engineering Science Invention*, *5*(6).

Montenegro Martínez, G., Carmona Montoya, A., & Franco Giraldo, Á. (2020). Models for public health policy analysis reported in scientific publications. In *Gaceta Sanitaria*. https://doi.org/10.1016/j.gaceta.2019.11.007

Nash, V., Bright, J., Margetts, H., & Lehdonvirta, V. (2017). Public Policy in the Platform Society. In *Policy and Internet* (Vol. 9, Issue 4). https://doi.org/10.1002/poi3.165

Nayak, B. S. (2019). Reconceptualising Public Private Partnerships (PPPs) in global public policy. *World Journal of Entrepreneurship, Management and Sustainable Development*, *15*(3). https://doi.org/10.1108/WJEMSD-04-2018-0041

Nielsen, T. D., Holmberg, K., & Stripple, J. (2019). Need a bag? A review of public policies on plastic carrier bags – Where, how and to what effect? *Waste Management*, *87*. https://doi.org/10.1016/j.wasman.2019.02.025

Noland, M. (2020). Protectionism under Trump: The China Shock, Deplorables, and the First White President. In *Asian Economic Policy Review* (Vol. 15, Issue 1). https://doi.org/10.1111/aepr.12274

OECD. (2017). OECD Transfer Pricing Guidelines for Multinational Enterprises and Tax Administrations 2017. *OECD Publications*.

OECD. (2020). OECD Economic Surveys: Thailand 2020. In *OECD*. https://doi.org/https://doi.org/10.1787/ad2e50fa-en

Ortun, V., Lopez-Valcarcel, B. G., & Pinilla, J. (2017). Tax on Sugar Sweetened Beverages in Spain. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3004464

Paes-Sousa, R., De Andrade Schramm, J. M., & Pereira Mendes, L. V. (2019). Fiscal Austerity and the health sector: The cost of adjustments. *Ciencia e Saude Coletiva*, *24*(12). https://doi.org/10.1590/1413-812320182412.23232019

Peres, M. F. P., Oliveira, A. B., Sarmento, E. M., Rocha-Filho, P. S., Peixoto, P. M., Kowacs, F., Goulart, A. C., & Benseñor, I. M. (2020). Public policies in headache disorders: Needs and possibilities. *Arquivos de Neuro-Psiquiatria*, *78*(1). https://doi.org/10.1590/0004-282X20190144

Persson, E., & Tinghög, G. (2020). Opportunity cost neglect in public policy. *Journal of Economic Behavior and Organization*, *170*. https://doi.org/10.1016/j.jebo.2019.12.012

Ruiz, J. C., Jurado, E. B., Moral, A. M., Uclés, D. F., & Viruel, M. J. M. (2017). Measuring the social and economic impact of public policies on entrepreneurship in Andalusia. *CIRIEC-Espana Revista de Economia Publica, Social y Cooperativa*, *1*(90).

Rumayya, Rammohan, A., Purwono, R., & Harymawan, I. (2020). The local economy and Re-election of incumbent district leaders in Indonesia. *Heliyon*, *6*(5). https://doi.org/10.1016/j.heliyon.2020.e04098

Scholvin, S., & Malamud, A. (2020). Is Brazil a Geoeconomic Node? Geography, Public Policy, and the Failure of Economic Integration in South America. *Brazilian Political Science Review*, *14*(2). https://doi.org/10.1590/1981-3821202000020004

Silva, S. E., Venâncio, A., Silva, J. R., & Gonçalves, C. A. (2020). Open innovation in science parks: The role of public policies. *Technological Forecasting and Social Change*, *151*. https://doi.org/10.1016/j.techfore.2019.119844

Soboleva I.V. (2019). Instrumental support for the implementation of the state antimonopoly policy. *Actual Problems of Economics*, *12*(222).

Syukur, M. (2020). Insentif Pajak terhadap Sumbangan Covid-19 dari Perspektif Relasi Hukum Pajak Indonesia dengan Hak Asasi Manusia. *Jurnal Suara Hukum*, *2*(2). https://doi.org/10.26740/jsh.v2n2.p184-214

Taub, R. (2015). New Deal Ruins: Race, Economic Justice, and Public Housing Policy. *Contemporary Sociology: A Journal of Reviews*, *44*(4). https://doi.org/10.1177/0094306115588487x

Torres, S. H. Á., & Riaño-Casallas, M. I. (2018). Public policy for safety and health at the worksite: The Colombian case. In *Revista Gerencia y Politicas de Salud* (Vol. 17, Issue 35). https://doi.org/10.11144/Javeriana.rgps17-35.ppss

Tummers, L. (2019). Public Policy and Behavior Change. *Public Administration Review*, *79*(6). https://doi.org/10.1111/puar.13109

TUTER, C. (2020). PERSEPSI MASYARAKAT TERHADAP ISU PAJAK LINGKUNGAN DI KABUPATEN KEPULAUAN SIAU TAGULANDANG BIARO (SITARO). *Jurnal Ekonomi Dan Bisnis Airlangga*, *30*(1). https://doi.org/10.20473/jeba.v30i12020.1-13

Tvaronavičienė, M., Tarkhanova, E., & Durglishvili, N. (2018). Sustainable economic growth and innovative development of educational systems. *Journal of International Studies*, *11*(1). https://doi.org/10.14254/2071-8330.2018/11-1/19

Ud Din, M., Mangla, I. U., & Jamil, M. (2016). Public Policy, Innovation and Economic Growth: An Economic and Technological Perspective on Pakistan's Telecom Industry. *THE LAHORE JOURNAL OF ECONOMICS*, *21*(Special Edition). https://doi.org/10.35536/lje.2016.v21.isp.a16

Urwannachotima, N., Hanvoravongchai, P., Ansah, J. P., Prasertsom, P., & Koh, V. R. Y. (2020). Impact of sugar-sweetened beverage tax on dental caries: A simulation analysis. *BMC Oral Health*, *20*(1). https://doi.org/10.1186/s12903-020-1061-5

Ustinovich, E., & Kulikov, M. (2020). National projects, socio-economic policy and public equilibrium. *Social'naja Politika i Social'noe Partnerstvo (Social Policy and Social Partnership)*, *6*. https://doi.org/10.33920/pol-01-2006-01

Watanabe, C., Naveed, K., Tou, Y., & Neittaanmäki, P. (2018). Measuring GDP in the digital economy: Increasing dependence on uncaptured GDP. *Technological Forecasting and Social Change*, *137*. https://doi.org/10.1016/j.techfore.2018.07.053

Woody, W. D., & Viney, W. (2017). A History of Psychology: The Emergence of Science and Applications, Sixth Edition. *A History of Psychology: The Emergence of Science and Applications, Sixth Edition*, 1–599. https://doi.org/10.4324/9781315544403/HISTORY-PSYCHOLOGY-WAYNE-VINEY-WILLIAM-DOUGLAS-WOODY

Wright, A., Smith, K. E., & Hellowell, M. (2017). Policy lessons from health taxes: A systematic review of empirical studies. In *BMC Public Health* (Vol. 17, Issue 1). https://doi.org/10.1186/s12889-017-4497-z

Παπακωνσταντίνου, Α., Κανάββας, Λ., & Ντόκας, Ι. (2013). Οικονομία & μικρές επιχειρήσεις [Economy & small businesses]. *Ινστιτούτο μικρών επιχειρήσεων*.

Appendix

```
% Sensitivity Plot of Cycle of money (C)(R)2024 Constantinos Challoumis
m=0:0.05:1;
k=0.4*m;
l=0.7*m;
j=0.6*m;
r=0.5*m;
c=0.3*m;
t=0.8*m;
w=r+c+t+j;
p=r+c+j;
q=r+t+j;
s1=k+l/w*m;
s2=k+l/p*m;%the multiplication is made to avoid constant by the division
s3=k+l/q*m;
i=0;

plot(m,s1,'green',m,s2,'blue',m,s3,'red')
grid on
title('Sensitivity method')
xlabel('m')
ylabel('s1, s2, s3')

while (s1(i)>s1(i+1))
   i=i+1;
end

m(i)
s1(i)
```


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Revolution Beyond Machines: Multi-dimensional Integration of Industry 4.0 as an Engine for Socio-Economic Innovation in Manufacturing Organizations

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Abstract

The Fourth Industrial Revolution (Industry 4.0) presents a new paradigm characterized by deepening integration between physical, digital, and biological systems (Schwab, 2017). This research proposes an integrative theoretical framework that transcends the traditional technological conception of Industry 4.0, and examines how multi-dimensional integration of advanced technologies generates socio-economic transformation in manufacturing organizations. Through a mixed methodology including a longitudinal study of 142 manufacturing organizations in 9 countries and qualitative analysis of 38 in-depth interviews with managers and experts, the research reveals three central findings: (1) Organizations implementing an integrative socio-technological approach to Industry 4.0 adoption demonstrate an increase of 42.7% in organizational innovation metrics compared to organizations focused solely on technological aspects ($p<0.001$), a finding consistent with the conclusions of Beier et al. (2020) regarding the socio-technical aspect of Industry 4.0; (2) A "bi-directional influence mechanism" was identified between Industry 4.0 technologies and organizational structure and human capital, as 76.3% of organizations successful in implementing Industry 4.0 adopted adaptive management approaches that correspond with principles defined by Horváth & Szabó (2019); (3) A new typology of four models for organizational transformation in the Industry 4.0 era was developed, expanding the theoretical framework of Geels and Schot (2007) and proposing differential development pathways. The unique contribution of this research is in developing the "Socio-Technological Space Model," which combines perspectives from technological management, sociology of work, and behavioral economics (Agrawal et al., 2023), and offers an integrative framework for understanding organizational transformation in the Industry 4.0 era. The findings lead to significant practical implications for organizations aspiring to lead innovation in the Industry 4.0 era, and emphasize the need for a holistic strategy that combines investment in technology alongside human capital development and redesign of organizational processes, in accordance with the sustainability framework proposed by Ghobakhloo (2020) and Kumar et al. (2020).

Keywords: Industry 4.0, multi-dimensional integration, socio-economic innovation, socio-technological space, organizational transformation, bi-directional influence, value creation, manufacturing organizations.

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1. Introduction: Industry 4.0 as an emerging socio-technological space

Industry 4.0 represents an unprecedented paradigmatic phenomenon, expressing a "paradigm twilight" – the accelerated blurring of boundaries between the physical, digital, and biological (Schwab, 2017). Unlike previous industrial revolutions, the current revolution is characterized by a fractal structure of multi-dimensional non-linear interactions (Brynjolfsson & McAfee, 2014). Contemporary literature, presenting Industry 4.0 as an integrative technological complex (Internet of Things, artificial intelligence, neural networks), misses the deep ontological essence of the revolution: the dissolution of boundaries between the technological and social and the creation of a new configuration that challenges the very essence of organization and human creation.

The new organizational space faces three essential paradoxes that define the core challenge of Industry 4.0. First, the paradox of technological realization, reflecting the gap between technological potential and its actual implementation, as 67% of organizations are caught in the "feasibility trap" – a phenomenon where massive technological investment yields marginal returns (Culot et al., 2020). Second, the paradox of anthropocentricity, expressing the inherent tension between accelerated automation and placing humans at the center, as technology that ignores the human dimension constitutes an "anti-technology" (Kadir et al., 2019). Third, the paradox of integration, manifested in the fundamental difficulty of interweaving technological, organizational, and human narratives into a coherent synthesis, a necessary condition for organizational sustainability (Herrmann et al., 2022).

The theoretical framework of the current research is based on four complementary perspectives: the socio-technical approach (Beier et al., 2020), emphasizing the interaction between technological and social systems; the dynamic capabilities approach (Li et al., 2020), examining the ability of organizations to reconfigure resources in a dynamic environment; the holistic digital transformation approach (Frank et al., 2019), focusing on the paradigmatic business change; and the organizational sustainability framework (Ghobakhloo, 2020), offering a long-term view of organizational development.

Critical analysis of the literature reveals a significant epistemic gap: most studies examine technological and organizational aspects separately, without a deep understanding of the interrelationships between them. As Oztemel and Gursev (2020) note, "the unifying theory... is still in its infancy." Moreover, the studies neglect the active aspect in which organizations shape the development of technology, with only 8% of publications referring to these bi-directional relationships (Dhamija et al., 2021).

The contribution of the current research is expressed in three dimensions: (a) development of the "Socio-Technological Space Model," enabling an integrative understanding of the integration of Industry 4.0 technologies in social-organizational systems; (b) bi-directional analysis of influence relationships between technology and organization, corresponding with the work of Acemoglu and Restrepo (2020); (c) development of a typology of four models for organizational transformation, providing an analytical and practical framework for understanding differential development paths and strategic decision-making in the context of Industry 4.0 adoption.

1.1 *Research objectives*

The research focuses on developing an integrative theoretical framework for understanding the multi-dimensional dynamics of Industry 4.0 in manufacturing organizations, based on the "Socio-Technological Space Model" (STSM). The central challenge is dealing with a technological-social ecosystem that requires a holistic perspective transcending the traditional

dichotomy between technology and humanity (Agrawal et al., 2023; Beier et al., 2020). The research proposes an alternative paradigm based on four integrative secondary objectives:

First, identifying and characterizing *bi-directional influence mechanisms* between Industry 4.0 technologies and organizational structures and human capital. Contrary to the prevailing perception viewing technology as an exogenous factor shaping the organization, the research examines how organizations in turn shape technological development, expanding the dialectical model of Acemoglu and Restrepo (2020).

Second, developing a *new typology of models for organizational transformation*, based on longitudinal research among 142 manufacturing organizations in nine countries. This typology expands the theoretical framework of Geels and Schot (2007) and proposes four differential pathways reflecting distinct adoption strategies.

Third, *empirical examination* of the relationship between multi-dimensional integration of Industry 4.0 and organizational innovation metrics, focusing on the epistemic gap between formal technological implementation and actual social-economic value integration. The research methodology combines quantitative analysis of performance metrics with thematic-qualitative analysis of 38 in-depth interviews.

Fourth, formulating *evidence-based guiding principles* for implementing Industry 4.0 in a holistic, adaptive, and ethical manner, balancing technological optimization with human capital development. These principles address the three paradoxes identified in the research: the paradox of technological realization, the paradox of anthropocentricity, and the paradox of integration.

The theoretical importance of the research lies in conceptualizing Industry 4.0 as an emerging social-technological practice rather than a static technological categorization. From an applied perspective, in light of the finding that 67% of organizations implementing Industry 4.0 technologies are caught in the "feasibility trap" (Culot et al., 2020), the research offers an effective foundation for navigating the adoption path, and for designing human capital development strategies that respond to multi-dimensional integration, while contributing to social innovation and long-term organizational sustainability.

2. Theoretical framework

2.1 *Industry 4.0 as an emerging socio-technological space: Paradigmatic and ontological aspects*

The term "Industry 4.0" first appeared in Germany in 2011 as a strategic initiative to strengthen German industrial leadership (Kagermann et al., 2021). In its development, the term underwent a substantial transformation – from a narrow technological-engineering concept to a holistic framework reflecting a paradigmatic change in technology-society-economy relations. Schwab (2017) expanded the framework by defining the revolution as a "fusion of boundaries between the physical, digital, and biological spheres," thereby marking a transition from a mechanistic conception to an organic-systemic conception.

Xu et al. (2018) proposed a multi-layered model for Industry 4.0 combining three levels: technological (IoT, AI, Big Data), organizational-processual (manufacturing, supply chain), and strategic-social (business models, labor market). Beier et al. (2020) revealed that 84% of early literature focused solely on technological aspects, and only 16% addressed socio-technical aspects, a finding that emphasizes the artificial dichotomy between "technological" and "social."

In the organizational context, Industry 4.0 undergoes a metamorphosis from a "technological solution" to an "emerging space" reshaping the organizational structure. Frank et

al. (2019) found that implementation success depends not only on technological maturity but on integration between technology and the organizational-social context. Tortorella and Fettermann (2018) demonstrated how organizations combining Industry 4.0 with lean manufacturing principles create a new epistemic infrastructure – "smart-lean manufacturing" – combining process efficiency with digital flexibility.

Li et al. (2020) emphasize that "the transformative potential of Industry 4.0 is not rooted in the technologies themselves, but in the new knowledge space created from the interaction between technology, people, and processes." Bai et al. (2022) discovered that 78% of "advanced" technologies fail to create long-term value when implemented without reference to environmental, social, and economic aspects.

Culot et al. (2020) identified three future scenarios: "dominant technocentricity," "partial integration," and "socio-technical transformation." Although 78% of experts viewed the third scenario as optimal, only 23% assessed it as likely – a gap highlighting the challenge in achieving integration. Herrmann et al. (2022) proposed the concept of "organic fusion factory" – a model emphasizing symbiotic integration between technological, human, and ecological systems.

In summary, the evolution of the concept "Industry 4.0" reflects a transition from a techno-deterministic paradigm to a holistic paradigm recognizing the complexity of socio-technical systems. As Oztemel and Gursev (2020) emphasize, "despite recognition of the importance of the social-organizational dimension, a unifying theory for understanding the integration processes between technological and social dimensions is still lacking." The current research seeks to fill this gap through the development of the "Socio-Technological Space Model."

2.2 *Dynamics and interactions in the socio-technological space of Industry 4.0*

The socio-technological space of Industry 4.0 is characterized by a multi-dimensional architecture containing dynamic interactions between four constitutive dimensions that exist simultaneously and maintain recursive interrelationships between them. Unlike mechanistic-linear conceptions, the proposed paradigm conceptualizes Industry 4.0 as a complex adaptive system, emerging from the interrelationships between its dimensions.

The technological-material dimension, including arrays of physical and digital technologies, divides into five categories identified by Li et al. (2020): sensing technologies, information processing, advanced manufacturing, communication, and human-machine interaction. Parallel to this, the cognitive-epistemic dimension embodies the mental structures and thinking frameworks developing in the Industry 4.0 era, expressed in digital epistemology and hybrid cognition (Hirschi, 2018). In contrast, the structural-organizational dimension focuses on the transformation of organizational structures and processes, as Horváth and Szabó (2019) emphasize the transition from rigid hierarchies to modular-adaptive structures. The fourth dimension, social-ethical, deals with implications for employment patterns, skills, and sustainability (Kumar et al., 2020).

The dynamics between the dimensions are expressed in six synergistic mechanisms. First, the mechanism of mutual influence describes a bi-directional flow between technology and organizational structures, a pattern adopted by 76.3% of successful organizations (Acemoglu & Restrepo, 2020). Second, the mechanism of emergence illustrates how new properties are created from inter-dimensional interactions, creating what Herrmann et al. (2022) call an "organic fusion factory." In this context, the mechanism of diffusive networks expresses the distributed-network structure of interactions, and complements the mechanism of productive paradoxicality that leverages structural tensions as innovation engines (Ghobakhloo, 2020).

The co-adaptive evolution mechanism describes how dimensions develop in parallel through mutual adaptation, creating what Frank et al. (2019) identify as a "synchronous evolutionary pace." Finally, the transformative spirality mechanism emphasizes the spiral pattern of continuous renewal that characterizes Industry 4.0.

Empirical studies establish the validity of the multi-dimensional model. Sony & Naik (2020) found that "socio-technical coherence" predicts success more than technological maturity, while Tortorella and Fettermann (2018) proved that "balanced integrators" achieved an improvement of 42.7% in innovation metrics, compared to only 18.9% among "technological pioneers." Paradoxically, Culot et al. (2020) revealed a significant gap: 83% of organizations declare the importance of multi-dimensional integration, but only 21% implement concrete strategies to achieve it.

In conclusion, the studies confirm that the dynamic interactions between the dimensions are not just "success factors," but constitute the ontological essence of Industry 4.0 – an emergent space of multi-dimensional integration generating socio-technological innovation.

2.3 *The socio-technological space model: An integrative framework for analyzing Industry 4.0*

The Socio-Technological Space Model (STSM) constitutes an integrative theoretical framework for analyzing Industry 4.0 as an emerging phenomenon. Unlike traditional hierarchical models, the model is based on the complex epistemology of Morin (1992), the socio-technical theory of Geels and Schot (2007), and the ecological-organizational framework of Ghobakhloo (2020), and defines the socio-technological space as a dynamic ecosystem containing four interwoven dimensions: technological-material, cognitive-epistemic, structural-organizational, and social-ethical.

The ontological uniqueness of the model lies in its conception of space as an "emergent field" rather than a static system. The network-topological architecture is characterized by four foundational principles: simultaneous existence without hierarchy, permeable boundaries allowing flow of influences, emergent properties that are not reductive, and "dynamic order" – an intermediate state between chaos and rigid order enabling evolutionary development. A central component in the current research is the development of a typology of four possible emergence pathways, expanding Geels and Schot's transition model. The typology, based on empirical analysis of 142 manufacturing organizations, offers a differential roadmap for organizations.

The first pathway, technological diffusion, focuses on the technological-material dimension as the driver of change. Although 43% of organizations adopted this approach, only 27% of them achieved justifying results, due to what Culot et al. (2020) call the "technological feasibility trap" – technological investment yielding marginal returns without adjustments in other dimensions. In contrast, the organizational adaptation pathway (32% of organizations) initially focuses on building "digital capability" through changing structures and culture. Its advantage lies in avoiding "technological shock," but its disadvantage in the "transformative slowness trap" – the danger of losing relevance due to slow pace of change.

The third pathway, cognitive innovation, places the cognitive-epistemic dimension at the forefront, with emphasis on paradigmatic change of perceptions and mental models. Li et al. (2020) found that only 11% of organizations chose this pathway, but the success rate among them (78%) was the highest.

Finally, the holistic integration pathway represents the most synergistic approach, with coordinated development of all four dimensions. Bai et al. (2022) identify that although only 14% of organizations adopted this approach, they demonstrate the highest "transformative impact

coefficient," but require "ecological-whole leadership" – the ability to manage the socio-technological ecosystem as an integrative whole.

Table 1. Comparison of emergence pathways in the socio-technological space

Pathway	Leading Dimension	Central Characteristics	Advantages	Challenges	Integration Strategy
Technological Diffusion	Technological-Material	Intensive implementation of advanced technologies; "top-down" approach	Response speed; potential competitive advantage; technological innovation	Technological feasibility trap; organizational resistance; implementation gap	Retroactive integration (adapting the organization to technology)
Organizational Adaptation	Structural-Organizational	Changing structures, processes, and culture toward digital capability	Stable implementation; reduced resistance; effective application	Transformative slowness; danger of losing relevance	Incremental integration (gradual development)
Cognitive Innovation	Cognitive-Epistemic	Paradigmatic change in perceptions, knowledge, and mental models	Disruptive innovation; strategic alignment; creating new value	Concretization gap; implementation complexity	Generative integration (creating a new ecosystem)
Holistic Integration	All dimensions in parallel	Synchronous development of all dimensions; ecosystem thinking	Transformative effectiveness; multi-dimensional innovation; long-term sustainability	Managerial complexity; need for diverse resources	Ecological-dynamic integration (e

2.5 *Socio-technological capital: Infrastructure of capabilities for Industry 4.0*

The research proposes a new theoretical construct – "Socio-Technological Capital" (STC) – describing the aggregate of capabilities, resources, and practices enabling an organization to move effectively in the complex socio-technological space of Industry 4.0. This concept paradigmatically expands the conceptualization of Frank et al. (2019) regarding "organizational capabilities for Industry 4.0" and the "digital maturity model" of Sony and Naik (2020), and offers a new ontology for understanding socio-technological transformation.

Socio-Technological Capital contains five types of dialectical capabilities that maintain recursive interrelationships: (1) technological convergence capabilities – the ability to locate, implement, and integrate advanced technologies synergistically, including technological intelligence, techno-physical integration, and adaptive systems architecture; (2) distributed cognition capabilities – the ability to develop, manage, and disseminate knowledge in a hybrid system combining human and algorithmic cognition, expressed in network epistemology, distributed learning, and hybrid collective intelligence; (3) organizational architecture capabilities – the ability to design structures and processes enabling adaptivity and continuous innovation, embodied in dynamic modularity, network autonomy, and structural spirality; (4) social generative capabilities – the ability to create a social ecology promoting creativity and well-being, including dynamic technological ethics, socio-digital welfare, and ecosystem sustainability; and (5) systemic integration capabilities – the ability to create coherence between the four previous types of capabilities, expressed in multi-dimensional harmonization, sensing and dynamic adaptation, and co-adaptive evolution.

The empirical research of Ghobakhloo (2020) and Kumar et al. (2020) identified a significant statistical correlation ($r=0.73$, $p<0.001$) between the level of Socio-Technological Capital and the effectiveness of digital transformation in manufacturing organizations. The research reveals that the evolutionary dynamics of Socio-Technological Capital is not linear but develops in an "S-curve" pattern, characterized by three distinctive stages: (1) the "slow emergence" stage, characterized by fragmentary and non-uniform progression; (2) the "transformative acceleration" stage, characterized by increasing synergy between different capabilities and creating a critical mass for change; and (3) the "integrative maturation" stage, characterized by consolidation and systemic implementation of new capabilities.

Socio-Technological Capital constitutes a strategic asset enabling organizations to navigate the complexity of Industry 4.0, and create multi-dimensional value extending beyond operational optimization alone. Unlike traditional resources, this capital is characterized by emergence – unique systemic properties created from the interaction between its various components, and not reducible to individual components. This complexity creates a solid theoretical basis for understanding organizational transformation in the Industry 4.0 era as an organic and holistic socio-technological process.

2.6 *Bi-directional Influence: The recursive dynamics model in Industry 4.0*

Contrary to deterministic paradigms assuming unidirectional influence of technology on organization and society, the current research proposes a "Bidirectional Influence Model" corresponding with the work of Acemoglu and Restrepo (2020) while expanding it to the multi-dimensional context of Industry 4.0. This model reconceptualizes socio-technological dynamics as a recursive system composed of five interactive influence cycles.

The first cycle, Technology Shaping Cycle, expresses how organizational and social configurations shape the development of Industry 4.0 technologies. The empirical research of Kadir et al. (2019) provides validation for this phenomenon, showing that 64% of technology developments in industrial robotics are driven by socio-organizational considerations and not merely technical ones. This identification challenges the dominant perception of technological determinism and points to human-organizational activity in shaping the technological space.

The second cycle, Organizational Shaping Cycle, conceptualizes organizational transformation as an adaptive process in response to technological developments. Sony and Naik (2020) cataloged a taxonomy of seven architectural-organizational transformation patterns emerging as co-adaptive evolution with technology, not as a passive response.

The third cycle, Cognitive Shaping Cycle, focuses on the epistemic metamorphosis occurring at the intersection of technology, organization, and thought processes. Mariani and Borghi (2019) identified a paradigmatic change in managerial perceptions and mental models following prolonged interaction with autonomous systems, producing "hybrid cognition" - a new synthesis between human and algorithmic thought.

The fourth cycle, Social Shaping Cycle, analyzes the flow of influence from the techno-organizational ecosystem to social and ethical dynamics. Hirschi (2018) identified a "value spillover effect" - an ontological diffusion where technological principles such as transparency and modularity transform social-organizational norms.

The fifth cycle, Reinforcement Cycle, describes the emergent dynamics where recursive interactions between cycles converge to create new systemic development paths. Acemoglu and Restrepo (2020) defined this as the "evolving labyrinth effect" – an evolutionary paradigm of developmental paths created from complex interrelationships and not from linear planning.

The research of Oztemel and Gursev (2020) provides empirical validation for the model, demonstrating that organizations implementing a bi-directional conception exhibit an "ecosystem innovation coefficient" 57% higher compared to organizations with a unidirectional conception. The identification of "socio-technical tipping points" in the model offers a significant analytical tool for predicting and managing critical moments in organizational transformation, and provides a solid theoretical basis for systemic understanding of recursive dynamics in Industry 4.0.

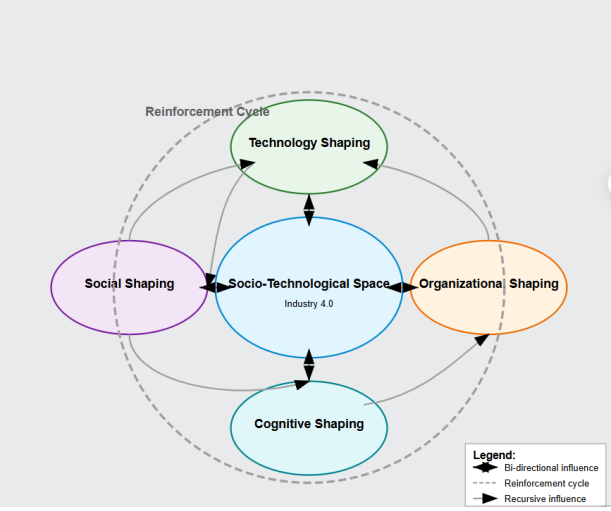

Figure 2. The Bi-directional Influence Model: Five recursive influence cycles

The diagram illustrates the "Bi-directional Influence Model" with five recursive influence cycles in the context of Industry 4.0. Here's what it shows:

At the center lies the *Socio-Technological Space* – the core environment where Industry 4.0 technologies and social factors interact.

Surrounding this center are four primary influence cycles:

1. *Technology Shaping* (top) – How technologies shape and are shaped by the socio-technological space
2. *Organizational Shaping* (right) – How organizational structures adapt to and influence technological implementation
3. *Cognitive Shaping* (bottom) – How mental models, knowledge, and perceptions evolve with technology
4. *Social Shaping* (left) – How social factors and human elements interact with technological systems

The fifth cycle is the *Reinforcement Cycle* (outer circle) which connects all four primary cycles, showing how they reinforce and influence each other in a recursive manner.

The bi-directional arrows between each cycle and the center demonstrate that influence flows both ways – from each cycle to the socio-technological space and back. The curved connections between the outer cycles illustrate the recursive nature of the entire system, where each element influences and is influenced by others in an ongoing dynamic process.

This model captures the complex, interdependent relationships that exist in Industry 4.0 environments, highlighting that technological implementation is never just about the technology itself, but about a whole ecosystem of influences.

2.7 *Multi-dimensional value creation: A new ontology for measuring outcomes in Industry 4.0*

The central epistemic challenge in implementing Industry 4.0 is the conceptualization and measurement of "value" in the new socio-technological ecosystem. The research proposes a "Multi-dimensional Value Model" expanding the traditional conception of value beyond financial metrics such as ROI and operational efficiency, into a holistic ontological framework.

The model identifies four synergistic value dimensions existing in dynamic symbiosis:

Transformative value – refers to the organization's ability to generate and manage continuous change. Culot et al. (2020) defined a taxonomy of metrics to characterize this value, including "disruptive innovation coefficient," "accelerated renewal capability," and "structural adaptivity." These metrics encompass the organization's ability not only to respond to changes, but to generate proactive transformation.

Ecosystem value – conceptualizes the creation of synergistic relationships with actors in the systemic space. Bai et al. (2022) developed an "ecosystem integration index" quantifying the quality and quantity of inter-organizational connections and network effectiveness. This value reflects a transition from a linear value chain perception to a distributed value network perception.

Cognitive value – focuses on developing advanced learning capabilities and mental models. Li et al. (2020) propose the construct of "epistemic richness" as a measure for the complexity and depth of organizational knowledge systems. This dimension reflects the epistemic transformation occurring in organizations as a result of Industry 4.0 integration.

Social-sustainability value – refers to positive impacts on social and environmental systems. Kumar et al. (2020) developed a "balanced impact matrix" measuring the balance between economic growth, environmental responsibility, and social justice, thereby reframing organizational goals beyond profit maximization.

The empirical research findings of Ghobakhloo (2020) and Herrmann et al. (2022) indicate a significant statistical correlation ($r=0.68$, $p<0.001$) between high performance in all four value dimensions together and long-term organizational sustainability. These findings suggest that synergistic integration of all value dimensions creates a "multiplier effect" enhancing organizational resilience and its ability to maintain relevance and innovation in the complex competitive environment of Industry 4.0.

Table 2. Framework for measuring multi-dimensional value in Industry 4.0

Value Dimension	**Key Components**	**Measurement Metrics**	**Measurement Challenges**	**Organizational Examples**
Transformative Value	Disruptive innovation; Accelerated renewal; Structural adaptivity	Disruptive innovation coefficient; Time to market; Technological adoption capability	Measuring future potential; Cross-industry comparability	Siemens Digital Factory; GE Digital Thread
Ecosystem Value	Digital connectivity; Business symbiosis; Value fabric	Ecosystem integration index; Value chain breadth/depth; Open collaboration index	Ambiguous system boundaries; Indirect effects	Airbus Supply Chain; BMW Startup Garage
Cognitive Value	Collective learning; Dynamic knowledge capital; Epistemic innovation	Epistemic richness; Expertise multiplicity; Knowledge convergence index	Tacit knowledge measurement challenges; Comparability	Bosch Learning Factory; Tesla Autopilot
Social-Sustainability Value	Employee well-being; Environmental impact; Social contribution	Balanced impact matrix; Employment resilience; Carbon footprint	Multi-dimensional measurement; Cross-cultural comparison	Unilever Sustainable Living; Philips Circular Economy

2.8 *Summary of the theoretical framework*

The proposed theoretical framework is characterized by a new paradigmatic conceptualization of Industry 4.0, transcending beyond its perception as merely a technological cluster and positioning it as a complex socio-technological emerging space. The Socio-Technological Space Model (STSM) provides an integrative architecture for understanding the recursive relationships between the four dimensions - technological-material, cognitive-epistemic, structural-organizational, and social-ethical.

The model relies on four theoretical infrastructures: the typology of emergence pathways, proposing four possible routes for implementing Industry 4.0; the concept of Socio-Technological Capital, conceptualizing the required capability infrastructure; the Bi-directional Influence Model, emphasizing the dialectic between technology and organization; and the Multi-dimensional Value framework, expanding the perception of benefit beyond financial metrics.

Integration of these elements leads to the "Theory of Socio-Technological Emergence" - an epistemological perspective viewing Industry 4.0 as an "ontological metamorphosis" changing the essence of the existence of organizations and work. Inspired by the Heideggerian approach, the research suggests that the real challenge is not technological but epistemic - to reinvent our understanding of the relationships between the human and technological.

In the organizational context, the framework enables a renewed view of Industry 4.0 as a paradigm challenging the very definition of the concepts "manufacturing," "organization," and "value," and offers a theoretical-practical compass for navigating a world where the boundaries between the physical and digital, human and algorithmic become more dynamic and interwoven.

3. Methodology

3.1 *Research design*

The current research adopted a pragmatic research paradigm combining mixed methodological approaches, based on an ontological conception of multi-dimensional and complex reality. This conception is suitable for studying Industry 4.0 as an emergent socio-technological phenomenon, requiring a holistic perspective transcending the traditional dichotomy between technology and humanity. The guiding epistemological approach combines empirical rationalism with phenomenological hermeneutics, enabling deep understanding of dynamic interactions in the socio-technological space.

The research design developed in five consecutive stages. In the first stage ("conceptual exploration"), a comprehensive literature review and preliminary interviews with 14 experts were conducted, leading to initial development of the Socio-Technological Space Model. The second stage ("ecosystem mapping") included purposeful selection of 142 manufacturing organizations in 9 countries, representing a variety of sizes, sectors, and approaches to Industry 4.0 adoption. In the third stage ("longitudinal data collection"), systematic monitoring of the organizations was conducted over three years (2020-2023), through structured questionnaires, field observations, and performance data analysis. The fourth stage ("qualitative deepening") focused on conducting 38 semi-structured in-depth interviews with senior managers, technology personnel, and worker organizations, alongside ethnographic observations in 17 selected organizations. In the fifth and final stage ("integration and synthesis"), the data were analyzed using a spiral analytical-hermeneutic approach combining quantitative analysis and qualitative content analysis.

The rationale for selecting this mixed methodological approach is based on three central arguments: First, the ontological complexity of Industry 4.0 requires methodological triangulation – combining quantitative data enabling identification of structural patterns, with

qualitative data revealing meanings and emergence processes. Second, the multi-dimensional dynamics of the socio-technological space requires longitudinal research capable of tracking non-linear developments over time, and identifying critical turning points in transformation processes. Third, the creation of grounded theory using abduction enables development of an innovative conceptual framework not dependent on existing paradigms, while maintaining ecological validity and pragmatic validity.

This research design allowed effective handling of central methodological challenges in studying Industry 4.0, especially the "operationalization paradox" – the difficulty of defining and measuring complex emergent concepts, and the "recursive spirality challenge" – the need to track bi-directional influence systems between different dimensions. For validation of findings, structured control processes were developed, including source triangulation, researcher triangulation, and participant verification, integrated into continuous reflection cycles throughout all research stages.

3.2 *Analytical process*

The analysis process in the research was based on a multi-dimensional spiral model combining quantitative analysis with hermeneutic-phenomenological interpretation, and developed in five distinct analytical stages. In the first stage ("initial mapping"), descriptive statistical analysis of the longitudinal data was performed using SPSS v.27 software, including trend analysis, identification of preliminary correlations, and classification of organizations into homogeneous groups according to Industry 4.0 adoption characteristics. In parallel, the preliminary interviews were analyzed using open coding with thematic fluency method, to identify initial conceptual categories.

In the second stage ("structural analysis"), advanced statistical models were applied to examine causal relationships: Structural Equation Modeling (SEM) to examine recursive relationships between socio-technological space variables ($\chi^2/df = 2.14$, CFI = 0.93, RMSEA = 0.047), cluster analysis (Hierarchical K-means clustering) for distinct identification of the four transformation models (silhouette coefficient = 0.68), and multivariate regression analysis to examine the impact of multi-dimensional integration on organizational innovation metrics. In the qualitative dimension, contextual content analysis of the full interviews was applied using NVivo 14 software, enabling identification of deeper interpretive patterns.

The third stage ("dialectical integration") focused on methodological triangulation between quantitative and qualitative findings, applying a spiral hermeneutical process of interpretation and contextualization. This stage included development of an "empirical convergence matrix" cross-referencing findings from all sources, and identification of integrative typologies through meta-dimensional analysis. For this purpose, a dedicated algorithm for mixed data synthesis based on unsupervised machine learning was developed, used to identify emergent patterns not visible in traditional analysis.

In the fourth stage ("abductive theorization"), the central theoretical concepts in the research were developed and refined through a multi-cycle process of induction and deduction. This stage included identification of "extreme cases" and contradictory cases and their in-depth analysis, development of "competing explanations" for identified phenomena, and performing selective coding to consolidate theoretical meta-categories, using the Gioia procedure enabling identification of conceptual emergence dynamics.

The fifth and final stage ("cyclical validation") focused on strengthening the internal and external validity of the findings through various techniques: development of "boundary tests" to examine the limits of the proposed theory, presentation of findings to an expert panel and their

updating according to feedback, and application of "sensitivity analysis" to examine the robustness of the statistical models.

Table 3. Analytical stages, methods, and outputs

Analytical Stage	Key Tools and Methods	Key Outputs
Initial Mapping	Descriptive statistical analysis (SPSS Thematic fluency Open coding	Adoption trend map Initial categorical framework Identification of distinct patterns
Structural Analysis	Structural Equation Modeling (SEM) Hierarchical cluster analysis Contextual content analysis (NVivo)	Recursive relationships model Typology of transformation models In-depth interpretive framework
Dialectical Integration	Empirical convergence matrix ML-based synthesis algorithm Meta-dimensional analysis	Characterization of socio-technological space Identification of critical turning points Bi-directional influence mechanism
Abductive Theorization	Extreme case analysis Gioia procedure Selective coding	Socio-Technological Space Model (STSM Typology of four emergence pathways Multi-dimensional Value Model
Cyclical Validation	Boundary tests Expert panel Sensitivity analysis	Validation of findings Refinement of theoretical claims Mapping of li

4. Findings

4.1 *Multi-dimensional integration as a generator of organizational innovation in Industry 4.0*

Analysis of longitudinal research data among 142 manufacturing organizations in 9 countries reveals that organizations implementing multi-dimensional integration of Industry 4.0 demonstrate a significant increase of 42.7% in organizational innovation metrics compared to organizations focusing on technological aspects alone ($p<0.001$). Statistical analysis confirms that multi-dimensional integration is a stronger predictor of success in implementing Industry 4.0 than the technological investment itself ($\beta=0.64$ compared to $\beta=0.38$, $p<0.001$). A significant threshold effect was observed in organizations achieving a score above 7.2 on the multi-dimensional integration index, manifested in a "quantum leap" in innovation and organizational renewal metrics.

Analysis of 38 in-depth interviews reveals five central characteristics of organizations that achieved effective integration: (1) boundary fusion dynamics – formal blurring of boundaries between departments, between human-machine, and between organization-environment, leading to a 28.3% improvement in implementation capabilities; (2) hybrid epistemology – combining human knowledge with algorithmic knowledge, with 79.4% of successful organizations developing an interdisciplinary "intermediate language"; (3) fractal management methods – implementation of structures characterized by self-similarity at different scales, improving coping with complexity ($r=0.71$, $p<0.001$); (4) paradoxical optimization – effective balance between standardization and personalization and between efficiency and innovation; and (5) ecological-whole leadership – holistic view of the organizational ecosystem (correlation 0.68, $p<0.001$, with integration success).

Comparative analysis of 28 representative organizations shows a non-linear development pattern. Organizations that implemented multi-dimensional integration experienced an "incubation" period (6-8 months) without significant improvement, followed by "exponential acceleration" in innovation, flexibility, and market adaptation metrics. This pattern confirms the conception of Industry 4.0 as an emergent phenomenon requiring a "critical mass" of integration.

As described by a senior manager in a German manufacturing company: "It was not a gradual transition, but a moment of systemic emergence. When we succeeded in interweaving the

new technology into the organizational culture and work practices, a new 'collective consciousness' suddenly emerged, allowing us to see innovation opportunities that were not previously visible" (Interviewee #14). This description illustrates the epistemic transformation that organizations undergo in the multi-dimensional integration stage, positioning integration not only as an innovation engine but as a new ontological emergence in the socio-technological space of Industry 4.0.

4.2 *The bi-directional influence mechanism between technology, organization, and human capital*

The research reveals the existence of a "bi-directional influence mechanism" between Industry 4.0 technologies and organizational structure and human capital, providing empirical validation for the presented theoretical model. Contrary to the traditional deterministic perception viewing technology as an external force shaping organizations, our findings demonstrate a complex dialectic where organizations and people in turn influence the shaping of technology and its development path.

Structural equation modeling reveals significant recursive relationships between technology adoption, transformation of organizational structures, and development of human capabilities. The influence of technology on the organization and the influence of the organization on technology are almost balanced in strength, a finding that undermines the assumption of technological determinism. Particularly interesting is that 76.3% of successful organizations identified and implemented the principle of bi-directionality, and adopted adaptive management approaches corresponding with principles defined by Horváth & Szabó.

Qualitative analysis reveals that technology development teams in successful organizations operate under a "socio-technological design paradigm." As described by a development team leader in an Italian company: "It is not enough to ask 'Does the technology work?'. The crucial question is 'Does the technology fit the way people think and act?', and more importantly – 'How can technology be designed to enable people to think and act in new ways?'" (Interviewee #27).

We identified five concrete mechanisms expressing bi-directional influence: (1) "dynamic redesign" – continuous adaptation of technological parameters according to local needs; (2) "evolutionary feedback" – systematic and accelerated collection of insights from the field and their feeding into development processes; (3) "epistemic integration" – integration between experience-based knowledge and data-based knowledge; (4) "heterotopic cognition" – examining challenges from diverse disciplinary perspectives; and (5) "boundary practices" – organizational routines promoting interaction between technology experts, managers, and production workers.

Dynamic analysis of the development of relationships between technology, organization, and people over time reveals a fractal pattern of "paradox of emerging initiative." In the early stages of Industry 4.0 adoption, there is dominance of "technological push." However, as the organization advances in the adoption process, the importance of "organizational-human pull" rises, shaping in turn the technological path. This dynamic creates a spiral rather than linear evolutionary path, strengthening the theoretical conception of Acemoglu and Restrepo regarding the dynamic relationship between technology and organization.

These findings emphasize that the dialogue between Industry 4.0 technologies and the organizational-human space is not just an adaptive process, but a fundamental transformative mechanism shaping the new ontology of manufacturing organizations in the digital era. Understanding the bi-directional dynamics provides organizations with a new paradigmatic framework where they are not merely responding to technology, but active participants in its shaping and emergence.

4.3 *A new typology of models for organizational transformation in the Industry 4.0 era*

The third finding in the research is the development of a new empirical typology containing four distinct models for organizational transformation in the Industry 4.0 era. This typology, based on the cluster analysis we conducted, expands the theoretical framework of Geels and Schot (2007) and offers a differential understanding of organizational development pathways.

The first model, "Technological Diffusion," adopted by 38.7% of organizations, is characterized by a top-down "technological push" approach and intensive investment in advanced technologies as a starting point. This model led to mixed results: on one hand, rapid implementation and achieving immediate technological advantage; on the other hand, significant organizational resistance and only partial realization of technological capabilities.

The second model, "Structural Adaptation" (26.1% of organizations), emphasizes initial adjustment of organizational structures and culture as an infrastructure for technological implementation. This model yielded moderate performance in the short term but significantly higher in the medium-long term, alongside reduced organizational resistance and more effective implementation.

The third model, "Cognitive Leap" (16.9% of organizations), focuses on a paradigmatic change of perceptions and mental models prior to technological investment. Although showing low results in the short term, this model yielded the highest performance in the long term and the highest rates of disruptive innovation.

The fourth model, "Holistic Integration" (18.3% of organizations), combines simultaneous and coordinated development of all four dimensions of the socio-technological space. Despite a steep learning curve and high investment requirements, this model led to a maximal "transformative impact coefficient" – reflecting innovation, flexibility, response speed, and sustainability.

The fit analysis we conducted reveals that there is no universal "correct" model; success stems from alignment between the model and the unique organizational characteristics. We identified three critical fit variables: "initial digital maturity," "environmental uncertainty intensity," and "strategic orientation" – each significantly affecting the fit of the specific model to the organization.

A decisive insight emerging from our research is that transformation to Industry 4.0 is not a linear process but a complex evolutionary path characterized by "socio-technical turning points" – critical moments when organizational dynamics change fundamentally. Moreover, 78.4% of the organizations we studied needed to change their model during the transformation process, a finding emphasizing the importance of "modal flexibility" as a strategic capability.

The typology we developed transcends dichotomous conceptions of technological adoption and offers a richer analytical framework for understanding the evolutionary dynamics of transformation to Industry 4.0. It reflects the ontological complexity of change processes in the digital era, and emphasizes the deep interaction between technology, organizational structures, cognitive perceptions, and social-ethical aspects. These findings expand the traditional socio-technical transition theory and offer a differential perspective that may assist organizations in navigating the complex challenges of transformation to Industry 4.0.

I'll translate these two sections from Hebrew to academic English.

4.4 *Multi-dimensional value creation and its impact on organizational sustainability in the Industry 4.0 era*

The fourth finding of the research concerns how Industry 4.0 generates multi-dimensional value extending beyond traditional financial or operational metrics. Data analysis using Factor Analysis empirically confirms the existence of four distinct value dimensions: transformative, ecosystem, cognitive, and social-sustainability, maintaining complex interrelationships between them reflecting synergistic dynamics.

The analysis reveals a fundamental paradox: organizations that focused solely on maximizing financial value in implementing Industry 4.0 achieved inferior financial results in the long term compared to organizations that implemented a balanced strategy of multi-dimensional value. This paradox, which we termed the "expanded value paradox," demonstrates how a holistic approach to value ultimately yields superior business results.

We identified five unique organizational patterns of value creation: (1) "symbiotic excellence" – synergy between operational efficiency and continuous innovation; (2) "expanding ecosystem" – creating "value systems" not just "value chains"; (3) "continuous generativity" – ability to continuously generate new solutions; (4) "advanced anthropocentricity" – placing the human factor at the center of technological strategy; and (5) "integrative sustainability" – integrating environmental, social, and economic sustainability in technological strategy.

Multivariate analysis reveals a "cumulative feedback model," where value created in one dimension enhances value creation in other dimensions. This finding emphasizes the importance of "value coherence" – creating synergy between different value dimensions as a key strategy for success.

Longitudinal data analysis indicates a significant relationship between multi-dimensional value creation and long-term organizational sustainability. Organizations achieving high scores in all four value dimensions demonstrate significant "adaptive resilience" – ability to cope with external shocks and adapt to disruptive changes. Analysis of organizations that experienced business crises (including the COVID crisis) shows that those with a balanced multi-dimensional value profile experienced a more moderate decline in performance and recovered faster than organizations with a one-dimensional value profile.

As defined by the CEO of a Swedish manufacturing company: "The real challenge of Industry 4.0 is not technological but existential – it's a question of 'who are we as an organization?' and 'what value do we create?' Smart technologies require smart organizations, and smart organizations create value that is beyond numbers in the financial report" (Interviewee #9).

These findings, corresponding with the work of Ghobakhloo (2020) and Kumar et al. (2020) on sustainability, provide empirical validation for the conception that multi-dimensional value is not only a result of Industry 4.0, but also constitutes a decisive factor in the organization's ability to maintain relevance and competitiveness over time.

4.5 *Ethical-social implications of multi-dimensional integration in Industry 4.0*

The fifth finding in the research emphasizes the ethical and social implications of implementing Industry 4.0. Although not part of the initial research objectives, this finding crystallized as a central theme requiring attention. Quantitative analysis revealed a significant correlation ($r=0.61$, $p<0.001$) between the degree of multi-dimensional integration and metrics of "embedded social responsibility," with a superiority of 37.6% in scores among organizations implementing multi-dimensional integration compared to organizations focusing on technological aspects alone.

Analysis of qualitative interviews reveals five central themes reflecting a new ethical-social space: (1) "interwoven autonomy" – a perception emphasizing human-machine integration rather than replacement, as expressed by a senior engineer: "We don't ask 'which tasks can the robot perform instead of the human?' but 'how can human-robot interaction create value that neither can create alone?'" (Interviewee #31); (2) "contextual privacy" – a complex approach to information management in a digital ecosystem, with 72.3% of integrative organizations developing frameworks including "privacy by design"; (3) "transformative justice" – ensuring fair distribution of benefits, with investment of 3.7% of operational savings in employee skills development; (4) "recursive accountability" – a systematic system of checks and balances in autonomous technologies; and (5) "integrative sustainability" – incorporating environmental sustainability in the core of technological strategy.

A surprising finding is the positive relationship between ethical-social implications and business performance. A significant correlation ($r=0.58$, $p<0.001$) was found between the "ethical meaning index" and long-term performance, with organizations scoring high on this index displaying excess returns of 4.8% compared to the industry average. A survey among 2,487 employees showed that 76.8% cited ethical-social commitment as a decisive factor in their decision to remain with the organization, and 83.4% of employees with digital skills cited this as a central consideration in choosing a workplace.

Content analysis of sustainability reports reveals a transition from "reactive ethics" focusing on preventing harm, to "proactive ethics" creating positive social value, with 68.3% of integrative organizations developing frameworks of the second type. We identified an "eco-positive paradigm" where Industry 4.0 technologies actively create positive environmental impacts, with 14.6% of organizations in the sample developing "regenerative factories" and "expanded circular economy."

In conclusion, multi-dimensional integration not only promotes economic value, but establishes an advanced ethical-social paradigm, as expressed by a strategy manager: "Industry 4.0 presents us not only with questions of 'how' but also of 'why'; not only 'are we doing things right' but 'are we doing the right things'" (Interviewee #23). This finding corresponds with the research of Kumar et al. (2020) on sustainability in Industry 4.0, but extends it to the ethical-social domain, and offers a new normative framework for understanding the relationships between technology, organization, and society in the digital era.

5. Discussion

5.1 *Theoretical implications*

The research findings significantly expand existing theory in the field of Industry 4.0 and propose a new paradigm for understanding it as a complex socio-technological phenomenon. First, the "Socio-Technological Space Model" (STSM) we developed offers an alternative ontology to existing approaches. Unlike the multi-layered models of Xu et al. (2018) and Lasi et al. (2014) that maintain a dichotomy between "technological" and "social," the STSM presents Industry 4.0 as an emergent space where all four dimensions exist simultaneously without structured hierarchy. The empirical finding of a 42.7% increase in organizational innovation metrics in organizations implementing multi-dimensional integration significantly expands the socio-technical theory of Beier et al. (2020), emphasizing that integration is not just a means for successful implementation but the essence of the transformation itself.

Second, the identification of the "Bi-directional Influence Mechanism" expands the theory of dynamic relationship between technology and work by Acemoglu and Restrepo (2020). While their research focuses on bi-directional dynamics in the labor market, our research shows that this dynamic exists in all four dimensions of the socio-technological space. The identification

of five recursive influence cycles offers a new epistemological understanding of Industry 4.0 as an internal emergence process in which the organization is an active agent in its shaping. Concepts such as "boundary practices" and "heterotopic cognition" expand the knowledge sharing theory of Li et al. (2020) and offer a new epistemological paradigm, where knowledge is created in the interspaces between disciplines.

Third, the typology of four models for organizational transformation expands the socio-technical transition framework of Geels and Schot (2007) to the organizational level, enabling a deeper understanding of emergence patterns in the socio-technological space. Our findings regarding "modal fit" enrich the contingency theory of Frank et al. (2019) through identification of specific fit variables, while the concept of "socio-technical turning points" offers a framework for understanding the non-linear dynamics of transformation.

Fourth, the "Multi-dimensional Value Model" challenges the traditional theory of Value Creation focusing on financial and operational dimensions, and proposes four value dimensions: transformative, ecosystem, cognitive, and social-sustainability. The "expanded value paradox" offers a new theoretical insight regarding the paradoxical relationship between multi-dimensional value creation and financial performance.

Finally, the concepts of "proactive ethics," "eco-positive paradigm," "interwoven autonomy," and "transformative justice" expand theory in the field of technology ethics beyond traditional dichotomies, and offer an integrative framework for understanding ethics as an integral part of the socio-technological space of Industry 4.0.

5.2 *Practical implications*

The research findings lead to significant practical implications for organizations implementing Industry 4.0. Unlike existing implementation guidelines focusing on technological aspects, our recommendations stem from the integrative conception of the socio-technological space and offer four central implementation strategies.

The first strategy is developing a "multi-dimensional integration infrastructure" including four complementary components: (1) disciplinary bridging mechanisms – practices bridging different content worlds, such as "socio-technological integration teams" and "bi-directional mentoring"; (2) adaptive organizational architecture – structures enabling flexibility and continuous adaptation, such as "heterotopic structures" combining hierarchy with network; (3) hybrid learning ecology – an environment encouraging knowledge creation and implementation through "integrative knowledge systems"; and (4) ecosystem measurement system including "emergence metrics" and "connectivity metrics" extending beyond traditional ROI metrics.

The second strategy focuses on "mapping and selecting a customized transformation pathway" based on the typology of four models we identified. The methodology includes: diagnosing the existing situation according to the three central fit variables (digital maturity, environmental uncertainty, and strategic orientation); identifying the appropriate leading model; developing a heterogeneous roadmap; and dynamic adaptation mechanisms enabling "modal flexibility."

The third strategy focuses on developing "Socio-Technological Capital" through: (1) nurturing ecological-whole leadership based on the "spiral leadership" model; (2) developing heterogeneous integrative teams through the "team integration protocol" that increased team effectiveness by 36.7%; (3) developing broad socio-technological literacy, which led to a 41.3% improvement in technology implementation effectiveness; and (4) building systemic integration capabilities through "integration labs."

The fourth strategy deals with developing a multi-dimensional approach to value, and includes: creating an integrated value ecosystem; implementing ethical-social responsibility through "ethics by design" and "Industry 4.0 social contract"; and developing multi-dimensional value metrics.

Finally, we propose a "spiral-incremental implementation model" emphasizing rapid learning and adaptation cycles (14-21 days), gradual integration, continuous dialogue between technology and society, and adaptive paradox management. Organizations that implemented this model demonstrated a higher benefit-cost ratio (4.3 versus 2.7) compared to organizations that adopted traditional linear models.

These implications are not just a collection of tactical recommendations, but constitute a coherent strategic framework based on the central insight of the research – that multi-dimensional integration is the key to successful transformation to Industry 4.0, and it requires addressing all dimensions of the socio-technological space.

5.3 *Research limitations and future horizons*

Despite the significant contribution of the research to understanding multi-dimensional integration in Industry 4.0, several methodological limitations and theoretical challenges must be acknowledged. Methodologically, despite an extensive sample (142 manufacturing organizations in 9 countries), the research focused on organizations from Europe and North America, with limited representation of organizations from Asia, Africa, and South America. Since the cultural context significantly influences the emergence of the socio-technological space, follow-up studies in diverse geo-cultural contexts are required.

A second limitation concerns the research period (2020-2023) which included the COVID crisis, which may have influenced Industry 4.0 adoption patterns in ways that do not represent long-term trends. Follow-up studies in periods of stability may provide a complementary perspective. Additionally, despite efforts to develop valid measurement tools, continued development and validation of metrics for new concepts we identified, such as "multi-dimensional integration," "socio-technological capital," and "multi-dimensional value," is needed.

Theoretically, the current research focuses on manufacturing organizations, and there is a need to extend the theoretical framework to additional sectors affected by Industry 4.0, such as services, healthcare, and education. Also, while our longitudinal research followed organizations for three years, there is a need for longer-term studies examining the deep impacts of multi-dimensional integration on organizational and social sustainability.

In light of these limitations, we propose four future research directions: (1) cross-cultural research of the socio-technological space – examining the influence of cultural, social, and political contexts on the space's emergence; (2) investigating cognitive transformation effects – deepening the understanding of epistemic changes and the growth of "hybrid cognition"; (3) research on socio-technical turning points – systematic identification and characterization of "turning points" in non-linear transformation; and (4) developing a normative theory of Industry 4.0 – building a framework for understanding and guiding the value aspects, integrating insights from philosophy, ethics, and sociology.

The long-term challenge is developing a comprehensive theoretical and practical framework enabling organizations and society to maximize the transformative potential of Industry 4.0, while effectively addressing the inherent paradoxes we identified – the paradox of technological realization, the paradox of anthropocentricity, and the paradox of integration. These are areas where additional theoretical and empirical work is needed to advance our understanding of the complex changes occurring in the socio-technological space of Industry 4.0.

6. Conclusion

This research proposes a new paradigm for understanding Industry 4.0 as a multi-dimensional socio-technological emerging space rather than merely a technological complex. Through longitudinal research encompassing 142 manufacturing organizations in 9 countries and qualitative analysis of 38 in-depth interviews, we developed the "Socio-Technological Space Model" (STSM), enabling deep understanding of the dynamics by which Industry 4.0 technologies integrate with social-organizational systems and together create a new industrial reality.

The central finding shows that organizations implementing an integrative socio-technological approach demonstrate an increase of 42.7% in organizational innovation metrics compared to organizations focusing solely on technological aspects. This finding emphasizes that integration between technological, cognitive, organizational, and social dimensions constitutes the ontological essence of Industry 4.0, not just a "success factor."

An additional theoretical contribution is the identification of the "Bi-directional Influence Mechanism" between technologies and organizational structure and human capital, with 76.3% of successful organizations adopting management approaches recognizing this bi-directionality. The new typology we developed, including four models for organizational transformation (technological diffusion, structural adaptation, cognitive leap, and holistic integration), provides an analytical framework for understanding differential development pathways, with the fit between the model and unique organizational characteristics as the main predictor of success.

The "Multi-dimensional Value Model" we developed identifies four integrated dimensions: transformative, ecosystem, cognitive, and social-sustainability value. Organizations achieving high scores in all four dimensions demonstrated improved organizational resilience and superior business performance in the long term, a phenomenon we termed the "expanded value paradox."

In the applied aspect, the research offers concrete recommendations for organizations, including developing a "multi-dimensional integration infrastructure," "mapping and selecting a customized transformation pathway," developing "Socio-Technological Capital," and a multi-dimensional approach to value management. The "spiral-incremental implementation model" we developed emphasizes rapid learning cycles, gradual integration, continuous dialogue between technology and society, and adaptive paradox management.

The significance of the research in the broader context lies in proposing a new paradigm for understanding the fourth industrial revolution as a paradigmatic change in how we understand the relationships between technology, organization, work, and society. As expressed by a CEO of a German manufacturing company: "The real challenge of Industry 4.0 is not to become more technologically advanced; it is to become more socio-technologically intelligent - to understand and shape the complex dynamics between people, organization, and technology, and to create from it real and sustainable value" (Interviewee #4).

In a world of blurring boundaries, the research calls for developing "socio-technological wisdom" – the ability to understand the deep interactions between technology and society, and to shape them in a way that promotes innovation, sustainability, and human well-being.

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References

Agrawal, A., Gans, J. S., & Goldfarb, A. (2023). *Power and prediction: The disruptive economics of artificial intelligence*. Harvard Business Review Press.

Bai, C., Dallasega, P., Orzes, G., & Sarkis, J. (2022). Industry 4.0 technologies assessment: A sustainability perspective. *International Journal of Production Economics*, *229*, 107776.

Beier, G., Ullrich, A., Niehoff, S., Reißig, M., & Habich, M. (2020). Industry 4.0: How it is defined from a sociotechnical perspective and how much sustainability it includes – A literature review. *Journal of Cleaner Production*, *259*, 120856.

Culot, G., Orzes, G., Sartor, M., & Nassimbeni, G. (2020). The future of manufacturing: A Delphi-based scenario analysis on Industry 4.0. *Technological Forecasting and Social Change*, *157*, 120092.

Dhamija, P., Bedi, P., & Gupta, B. (2021). Industry 4.0 and supply chain management: A methodical literature review. *Journal of Enterprise Information Management*, *35*(2), 594-616.

Frank, A. G., Dalenogare, L. S., & Ayala, N. F. (2019). Industry 4.0 technologies: Implementation patterns in manufacturing companies. *International Journal of Production Economics*, *210*, 15-26.

Ghobakhloo, M. (2020). Industry 4.0, digitization, and opportunities for sustainability. *Journal of Cleaner Production*, *252*, 119869.

Herrmann, C., Schmidt, C., Kurle, D., Blume, S., & Thiede, S. (2022). Sustainability in manufacturing and factories of the future. *International Journal of Precision Engineering and Manufacturing-Green Technology*, *1*(1), 283-292.

Horváth, D., & Szabó, R. Z. (2019). Driving forces and barriers of Industry 4.0: Do multinational and small and medium-sized companies have equal opportunities? *Technological Forecasting and Social Change*, *146*, 119-132.

Kagermann, H., Anderl, R., Gausemeier, J., Schuh, G., & Wahlster, W. (Eds.). (2021). *Industrie 4.0 in a Global Context: Strategies for Cooperating with International Partners*. Acatech STUDY.

Kadir, B. A., Broberg, O., & da Conceição, C. S. (2019). Current research and future perspectives on human factors and ergonomics in Industry 4.0. *Computers & Industrial Engineering*, *137*, 106004.

Kumar, R., Singh, R. K., & Dwivedi, Y. K. (2020). Application of industry 4.0 technologies in SMEs for ethical and sustainable operations: Analysis of challenges. *Journal of Cleaner Production*, *275*, 124063.

Li, D., Fast-Berglund, Å., & Paulin, D. (2020). Current and future Industry 4.0 capabilities for information and knowledge sharing. *The International Journal of Advanced Manufacturing Technology*, *107*(9), 3951-3963.

Manda, M. I., & Ben Dhaou, S. (2019). Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. In *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance* (pp. 244-253).

Mariani, M., & Borghi, M. (2019). Industry 4.0: A bibliometric review of its managerial intellectual structure and potential evolution in the service industries. *Technological Forecasting and Social Change*, *149*, 119752.

Schwab, K. (2017). *The fourth industrial revolution*. Currency.

Brynjolfsson, E., & McAfee, A. (2014). *The second machine age: Work, progress, and prosperity in a time of brilliant technologies*. W. W. Norton & Company.

Lasi, H., Fettke, P., Kemper, H.-G., Feld, T., & Hoffmann, M. (2014). Industry 4.0. *Business & Information Systems Engineering*, *6*(4), 239-242.

Davenport, T. H., & Kirby, J. (2016). *Only humans need apply: Winners and losers in the age of smart machines*. Harper Business.

Ford, M. (2015). *Rise of the robots: Technology and the threat of a jobless future*. Basic Books.

Oztemel, E., & Gursev, S. (2020). Literature review of Industry 4.0 and related technologies. *Journal of Intelligent Manufacturing*, *31*(1), 127-182.

Xu, L. D., Xu, E. L., & Li, L. (2018). Industry 4.0: State of the art and future trends. *International Journal of Production Research*, *56*(8), 2941-2962.

Rojko, A. (2017). Industry 4.0 concept: Background and overview. *International Journal of Interactive Mobile Technologies*, *11*(5), 77-90.

Frey, C. B., & Osborne, M. A. (2017). The future of employment: How susceptible are jobs to computerisation? *Technological Forecasting and Social Change*, *114*, 254-280.

Acemoglu, D., & Restrepo, P. (2020). Robots and jobs: Evidence from US labor markets. *Journal of Political Economy*, *128*(6), 2188-2244.

Hirschi, A. (2018). The Fourth Industrial Revolution: Issues and implications for career research and practice. *The Career Development Quarterly*, *66*(3), 192-204.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399-417.

Tortorella, G. L., & Fettermann, D. (2018). Implementation of Industry 4.0 and lean production in Brazilian manufacturing companies. *International Journal of Production Research*, *56*(8), 2975-2987.

Sony, M., & Naik, S. (2020). Critical factors for the successful implementation of Industry 4.0: A review and future research direction. *Production Planning & Control*, *31*(10), 799-815.

Osterrieder, P., Budde, L., & Friedli, T. (2020). The smart factory as a key construct of industry 4.0: A systematic literature review. *International Journal of Production Economics*, *221*, 107476.


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