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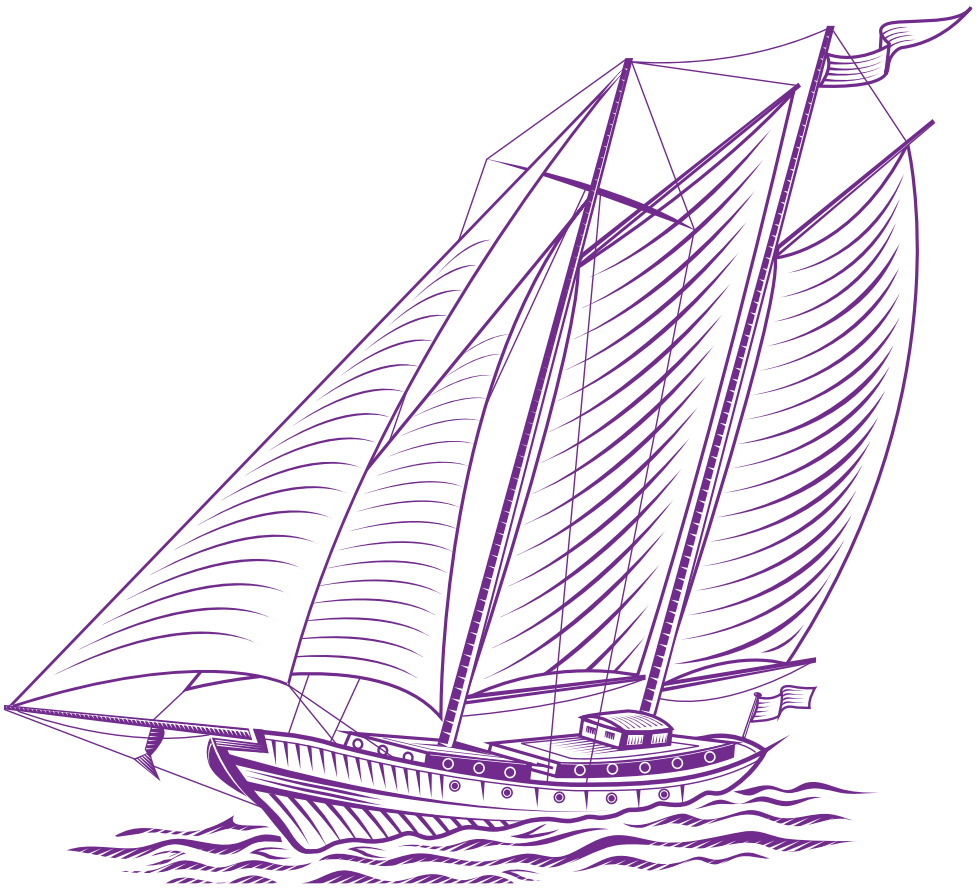

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PRE- AND POST-PANDEMIC ANALYSIS OF PORTUGAL'S ACCOMMODATION AND FOOD SERVICES SECTOR: A SHIFT-SHARE APPROACH

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ABSTRACT. Portugal's tourism industry is essential to the nation's economy, significantly contributing to wealth creation and employment opportunities. However, the onset of the global COVID-19 pandemic in 2020 severely impacted this vital sector. The accommodation and food services were particularly hit, with many businesses facing widespread closures. By early 2022, Portugal's economy faced additional hurdles. Geopolitical tensions and rising inflation created further disruptions on a global scale, complicating the recovery process. Despite these obstacles, Portugal's accommodation and food services sector began to show promising signs of recovery. To gain a deeper understanding of these dynamics, this paper utilizes shift-share analysis to examine the post-pandemic business landscape of Portugal's accommodation and food services sector, focusing on data from 2019 to 2022 for active businesses and the number of persons employed. This analytical method breaks down growth into national, sectoral, and regional components, providing a comprehensive view of the factors influencing recovery. The findings indicate that regional and industrial factors played a more significant role in driving recovery than national economic trends alone. Notably, regions such as the Algarve, Madeira, and Açores demonstrated remarkable resilience and growth. These areas benefited from their unique competitive advantages within the sector, which helped them navigate the challenging post-pandemic environment more effectively. The study's

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insights are invaluable for policymakers and investors. By understanding the importance of regional policies and innovation, stakeholders can make targeted decisions that enhance the sector's competitiveness and sustainability.

Keywords: business dynamics; accommodation; food services sector; tourism; shift-share analysis, Portugal

JEL classification: L83, R11, Z30

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Introduction

Before the COVID-19 pandemic, the World Travel and Tourism Council (WTTC) reported that tourism was the second fastest-growing sector (close to the manufacturing sector), accounting for about 10% of global economic activity. In 2019, before the pandemic, the industry grew more than other service sectors, such as healthcare (3.1%) and information technology (1.7%). At the time, travel and tourism (including its direct, indirect, and induced impacts) accounted for 10.5% of all jobs and 10.4% of global GDP. In 2023, the sector accounted for a number of jobs 1.4% below the 2019 level and contributed 9.1% to the worldwide GDP - an increase of 23.2% from 2022 but 4.1% below the 2019 level (WTTC, 2023). In Portugal, the most recent numbers released indicate that, in 2022, the tourism sector came close to 2019's record figures in the leading indicators of overnight stays (-0.9%) and guests (-2.3%) and surpassed the figures for tourist receipts (+15.4%). A total of 26.5 million guests were registered, 15.3 million foreigners, representing a recovery of 83.3 % and 158.5 %, respectively, compared to the same period last year. However, these figures are still (-2.3%) and (-6.8%) away, respectively, from those recorded in 2019. Projections for 2023 indicate that this will be a record year for the sector, which is thought to be the best year ever for the industry in the Portuguese economy (Turismo de Portugal, 2024).

Accommodation (hospitality) and food services (food and beverage) are fundamental tourism-dependent businesses and have a unique role in the overall tourism industry (Dogru et al., 2023; Rodríguez-Antón & Alonso-Almeida, 2020). They are not just a beneficiary of tourism activity but an essential component that shapes the quality and sustainability of the tourism experience. The accommodation and food services sector, which is fundamental for the overall tourism experience

and supporting infrastructure for tourism activities, plays a crucial role in tourism activity due to its economic and social driver contribution - job creation, revenue generation, and Gross Domestic Product (GDP) contribution.

The financial health, vitality, and resilience of accommodation and food services are vital for the overall success and sustainability of the tourism industry. However, the accommodation and food services sector is known for a high employee turnover. Nevertheless, the extent to which employee turnover in these industries depends on overall economic activities or idiosyncratic characteristics of the hospitality industry is not clear (Dogru et al., 2023). During crises, this turnover is heightened. Therefore, the operating strategies of hospitality and food services companies are compelled to change in response to crises like COVID-19. These occurrences create significant uncertainty and often call for swift action to mitigate adverse effects (Rodríguez-Antón & Alonso-Almeida, 2020).

Indeed, tourism, hospitality, and food and beverage are strictly intertwined economic sectors whose dynamics, opportunities, and (cor)related activities have been studied in the literature, with most recent studies focusing on the resilience of such sectors after periods of crises like the COVID-19 pandemic. The use and acknowledgement of qualitative methods in the previously mentioned research fields have brought a deeper understanding of the social, cultural, and political ties within and between tourism, hospitality, and food services (Provenzano & Baggio, 2020). One of the quantitative methods of analysis applied to these sectors of activity is the shift-share analysis. This is a powerful tool for understanding the dynamics of business sectors due to its ability to decompose industry growth into components that reveal national, regional, and sectoral underlying trends and factors. By understanding past performance - the underlying component driving the sector's evolution - the shift-share analysis is a tool that can help anticipate future dynamics of policy development and competitive positioning, inform strategic decision-making, and guide investments and resource allocation to foster sustainable growth in a specific sector, like the accommodation and food services one. The relevance of such quantitative analysis is proven by a set of literature that studies tourism and hospitality (Costantino et al., 2021; Dogru et al., 2021; Krabokoukis & Polyzos, 2021; Benítez-Aurioles, 2020; Fernando, 2020; Dogru & Sirakaya-Turk, 2017). The methods have also been applied to the Portuguese economy to understand "the dynamics and characteristics of the Portuguese tourism industry" in what is considered a "first step toward formulating a strategy aimed at improving Portuguese competitive standing in the growing tourism market" (Yasin et al., 2004, p. 11).

Considering the importance of the tourism industry overall, particularly the accommodation and food services in Portugal, this paper applies the shift-share analysis to administrative data on the number of businesses and persons

employed in the accommodation and food services activities before and after the COVID-19 pandemic. National, regional, and sectoral data on the two indicators has been collected for 2019 (the year before the pandemic started) and 2022 (the last year for which there is available data) for the Portuguese economy. The objective is to understand how accommodation and food services activities recovered from the crisis that hit the sector and which component (national, regional or sectoral) allowed their recovery and resilience. The analysis allows us to dissect the growth of the accommodation and food services activities into national, industrial, and regional components. This is whether the evolution of these activities is due to overall economic trends, specific sector trends, or unique regional factors, providing a more nuanced understanding of the market dynamics. At the same time, the analysis assesses these activities' resilience in the face of unprecedented challenges posed by the pandemic.

This paper is divided into five parts. After this introduction, a brief literature review is presented on the recovery and resilience of the tourism industry as a whole and, in particular, the accommodation and food services sector after the COVID-19 pandemic. It follows a section devoted to the data and methods applied to reach the paper's objective and a section dedicated to presenting and discussing the results of applying the shift-share analysis to the Portuguese data. The paper concludes with some final considerations.

Brief literature review

The global COVID-19 pandemic and the ensuing lockdowns have had dramatic consequences for the tourist industry worldwide, with many businesses in the accommodation and food services activities closing, leading to the unemployment of many human resources. Such facts conducted intense research on how the tourism and hospitality industry cope with the COVID-19 economic and social consequences. Immediately after the pandemic ended, Utkarsh & Sigala (2021) found 177 papers exploring the extensive academic landscape surrounding COVID-19's impacts on tourism and hospitality. Also, a synthesis of the findings from 407 empirical studies published in the major tourism and hospitality journals is made by Huang & Wang (2023). The studies identified by the authors try to explain the impact of the COVID-19 pandemic on consumer behaviour, response actions, recovery strategies, the broader industry, and employees. Such research shows the importance of the health crisis in the tourism and hospitality industry. Another research, utilising a mixed-method approach that includes both content and bibliometric analysis, identifies that over 70% of the initial research on the impact of COVID-19 on tourism and

hospitality focused primarily on responses to the COVID-19 challenges. These findings aim to help academics and industry professionals understand the evolving landscape of tourism and hospitality research under the constraints of the pandemic and suggest the need for continuous review to capture shifts in research focus over time (Ye et al., 2023).

Much of the previously mentioned research was concerned with the strategic adaptations necessary for resilience and recovery in the tourism and hospitality sectors during the pandemic since the acceleration of technological integration, the issues in globalisation, and the logistical inefficiencies that have reshaped industry operations (Colmekcioglu et al., 2022; Nyagadza et al., 2022). This was particularly relevant for small and medium-sized businesses (SMEs). If tourism is one of the hardest-hit industries by the global pandemic, small tourism enterprises have been heavily affected and have had more difficulties in business recovery (Sobaih et al., 2021). Tunio et al. (2021) identify various adaptive strategies for these businesses, including modifying operational practices, implementing strict health protocols, and leveraging digital technology to maintain customer engagement and manage expectations during the crisis.

The tourism industry suffered the worst impact due to the spread of the COVID-19 pandemic, with Europe the region whose tourism industry has been hardest hit globally (Saputra, 2023). In the European Union (EU), a broad range of public intervention strategies were deployed throughout the region to strengthen the hospitality sector during the COVID-19 crisis. Employing a case study approach, the research of Sanabria-Díaz et al. (2021) scrutinises the literature concerning the pandemic's repercussions. The authors explain the targeted interventions at different levels: individual tourists, tourism industry entities, and EU nations' comprehensive destination management. With analysis from the perspectives of supranational governance and stakeholder theory, the study provides an understanding of the collaborative endeavours to alleviate the pandemic's impact on this vital economic area. Indeed, they conclude that public policies are decisive in combating the effects of COVID-19 on the tourism and hospitality industry and that different COVID-19-related public rescue strategies for the tourism and hospitality sector at the individual, business and destination levels were needed.

Saputra (2023) explored the repercussions of the COVID-19 pandemic on the tourism industry, specifically focusing on the hotel and aviation sectors across Europe, considering the spatial interdependencies among regions. His findings confirm the presence of a significant spatial dependence in Europe concerning the pandemic's impact on tourism. This conclusion suggests that recovery or decline in one European country's hotel and aviation sectors can positively or negatively influence adjacent countries. Overall, Saputra's (2023)

study highlights the intricate interplay between various factors affecting the tourism industry during the pandemic, underscoring the critical role of spatial dependencies in understanding regional impacts. The importance of the regional analysis to understand the COVID-19 impact on tourism and hospitality has been highlighted in the literature worldwide. China, Indonesia, Brasil, EUA and other countries have been subject to regional analysis. In the European Union, it can be given the example of Spain. Benítez-Aurioles (2022) examines the impact of the COVID-19 pandemic on the peer-to-peer (P2P) tourist accommodation market across regions in Spain. Using data gathered by the Spanish National Statistics Institute, the study employs a shift-share analysis to dissect the reduction in overnight stays in 2020 compared to 2019. The findings reveal a significant decline of nearly 60% in overnight stays within the P2P market throughout the initial year of the pandemic, with notable regional disparities. Moreover, the analysis indicates no general correlation between regional specialisation in specific source markets and competitive advantage, which suggests that specialisation did not universally benefit regions in mitigating the decline in their specialised markets relative to the national trend.

For the Portuguese economy, Lopes et al. (2021) used a comprehensive dataset of personal and job-related attributes from 56,142 individuals in the industry to analyse factors influencing vulnerability to unemployment during the crisis. Their results reveal that older individuals, those with lower education and qualifications, women, and residents in regions with dense populations and high tourism activity were more vulnerable to unemployment during the pandemic. Their work is pivotal as it thoroughly examines how socio-demographic, work-related, and regional factors contribute to employment vulnerability in a key economic sector during an unprecedented global crisis. The authors recommend policy measures to boost worker resilience and industry competitiveness, especially in the most affected sub-sectors and regions. The regional perspective is fundamental to developing strategic measures since the Portuguese tourism sector exhibits significant developmental disparities across regions, with localized spillover effects contributing to the spatial clustering of economic activities (Santos & Vieira, 2020).

Research methodology

The main goal of this study is to scrutinise the regional and sectoral business dynamics of the accommodation and food services sector in Portugal, focusing on the number of active businesses and employment levels in the sector in 2022 compared to the year 2019. The year 2019 was considered the

best year for tourism-related activities in the Portuguese economy and was the year before the COVID-19 global pandemic. The year 2022 is considered the year Portugal experienced a resurgence in the demand for its hospitality and restaurant services being important to understand how national macroeconomic trends, sectoral specialization and regional characteristics are relevant to explain the accommodation and food services sector resilience and recovery.

To achieve the goal of this work, a shift-share analysis is applied to quantitative information publicly available on the Portuguese National Statistical Office - INE (INE, 2024), on the number of active businesses operating in the accommodation and food services sector and the number of persons employed on the sector. In this research, the information on the two variables will be analysed regarding the whole Portuguese economy, the 17 main activity sectors of the economy - according to the Portuguese Statistical Classification of Economic Activities (CAE Revision3) equivalent to the Statistical Classification of Economic Activities in the European Community (NACE Rev.2) - and the regional tourism divisions that overlap the seven main Portuguese administrative regions (Norte, Centro, Lisboa e Vale do Tejo (LVT), Alentejo, Algarve, Açores and Madeira).

Data is obtainable for the investigated period - from 2019, the period before the worldwide pandemic, untill 2022, the last year information exists available. The number of active businesses indicates the number of legal entities (individual and corporate businesses) corresponding to an organisational unit producing goods and/or services, enjoying a certain degree of decision-making autonomy, particularly concerning the allocation of its current resources. Regarding the number of persons employed, the indicator considers the number of persons who, during the reference period, participated in the business activity, regardless of the duration of this participation (INE, 2024).

First introduced by Dunn (Dunn, 1960), the shift-share analysis is a methodological framework that decomposes the data along three dimensions: the national 'share component' alongside the sectoral (industrial) and regional (local) 'shift components' (Artige & van Neuss, 2014). Employing this analytical instrument provides a detailed understanding of how each element influences regional economic activities, emphasising the effects of national growth, comparing industry-specific growth rates to the national average, and the regional industries' competitive advantages or disadvantages. Cost-efficient and effective shift-share analysis is used to evaluate the competitive perspective of regional industries within the broader context of national economic advancement. The shift-share analysis explains economic change as a combination of three factors that influence it: national – the share component - and sectoral and regional – the shift components. It presents a dynamic picture of the contribution of each factor to local growth: the driving effect of national growth, the specific mix of

sectors of activity and its growth rate compared to the national average, and the relative competitive advantage/disadvantage of the regional sectors (Goschin, 2014). A vast body of research literature uses shift-share analysis in different areas of study. Since the early 1960s, the shift-share analysis, in its traditional form and more recently developed forms, has been applied in many fields, such as spatial economics, political economics, geography, urban planning, international trade, firm demography and, more recently, tourism (Dogru et al., 2021; Benítez-Aurioles, 2020; Fernando, 2020; Dogru & Sirakaya-Turk, 2017). According to these authors, from an economic theoretical perspective, applying the shift-share technique in alternative contexts can demonstrate its efficacy and adaptability in analysing the changes in tourism and hospitality development in a particular country or region based on global economic, industry, and competitive growth.

The essential idea of the shift-share analysis is to find out the extent to which the difference in growth between each region and the national average is due to the region performing uniformly better than average in all sectors or to the fact that the region happens to be specialised in fast-growing sectors (Esteban, 2000). According to Cheng (2011) and Stimson et al. (2006), traditional shift-share analysis decomposes economic changes in a region into three additive components: business cycle (national share = NS), sectoral composition (sectoral mix = SM), and regional advantage (regional shift = RS). The three components sum to the total shift (TS). In the case of this work, the actual growth in the number of businesses actively working in the accommodation and food services sector and the number of persons employed in it can be represented by equation (1) that follows the work of Cheng (2011):

$$TS = NS + SM + RS \tag{1}$$

The formulas for each component are presented and explained below.

The national share component (NS) – equations (2) - measures the regional change in an analysed variable, in this case, the absolute and relative change in the number of businesses active during a given year/the number of persons employed in the active businesses that could have occurred if the regional change was at the same rate as the national economy.

$$NS = \sum_i^n E_{irt} \times g_n \qquad with \qquad g_n = {}^{(E_{nt^*} - E_{nt})}/_{E_{nt}} \tag{2}$$

Where E_{irt} is the number of active businesses/number of persons employed in sector i of region r at the beginning of a time interval t (in this case, the year 2019), g_n is the overall national rate of active businesses/persons employed growth in the time interval from t to t^*(t^* being the end of the time interval that, in this work, is

the year 2022), and E_{nt^*} and E_{nt} are, respectively, the number of active businesses/ persons employed in the whole economy at time t^* (2022) and the time t (2019). This research uses data on the number of active businesses/persons employed for the full Portuguese economy to calculate the national share component in the analysis.

The sectoral mix component (SM) measures the proportional shift due to a difference in sector growth between the region considered (each one of the seven Portuguese NUT III regions) and the national economy (the Portuguese economy as a whole) - equations (4):

$$SM = \sum_i^n E_{irt}(g_{in} - g_n) \qquad with \qquad g_{in} = {(E_{int^*} - E_{int})}/{E_{int}} \tag{4}$$

In the above formulas g_{in} is the national rate of active businesses/persons employed growth in sector i during the time interval from t to t^* (from 2019 to 2022), and E_{int^*} and E_{int} are, respectively, the number of active businesses/persons employed in sector i in the economy at time $t^*$and the time t. In this research, the sectoral mix component includes data for all the non-financial businesses registered in the economy 17 different sectors.

The regional shift component (RS) measures the differential shift due to differences in rates of growth of the same sector between the region and the national economy as a result of various factors (national resources, other comparative advantages or disadvantages, leadership and entrepreneurial ability, the effects of regional policy, among others). The formulas for this component are presented below (equations 5):

$$RS = \sum_i^n E_{irt}(g_{ir} - g_{in}) \qquad with \qquad g_{ir} = {(E_{irt^*} - E_{irt})}/{E_{irt}} \tag{5}$$

Where g_{ir} is the active businesses/persons employed growth rate in the same time interval from t to t^* in sector i in region r, and E_{irt^*} and E_{irt} are the number of firms/persons employed in sector i in region r at time t^* and t.

To understand the regional relevance of the accommodation and food services – considering the two variables in the study – in each one of the seven Portuguese regional tourism divisions is calculated the location quotient (LQ) using equation (6):

$$LQ = \left({X_i}/{\sum_i^n X_i}\right) \Big/ \left({N_i}/{\sum_i^n N_i}\right) \tag{6}$$

In equation (6), LQ is the location quotient, Xi is the value of the study variable for the chosen sector of activity in region i, $\sum_i^n X_i$ is the value of the variable for all sectors in the same region, is the value of the economy's variable in the selected sector, and $\sum_i^n N_i$ is the total value of the variable for all sectors in the economy (Wheeler, 2005). An LQ equal to 1 indicates the region has a balanced sector share compared to the full economy. An LQ inferior to 1 indicates a region less concentrated in the sector than the full economy while an LQ superior to 1 indicates a region more concentrated in the sector of activity than the economy.

The ratio is an important geographic index, often used to analyse the relative distribution or concentration of a specific aspect within a subarea compared to a larger reference area, providing a clear and insightful means to identify and visualise disparities in spatial data. It allows for a comparative assessment of how a particular region participates in a specific economic activity relative to a larger reference area (Krabokoukis & Polyzos, 2020). Indeed, it gives valuable insights into regional characteristics and disparities, aiding in decision-making and strategic planning. The ratio is, therefore, commonly used in regional research that applies the shift-share methodology (Irving et al., 2023; Broxterman & Larson, 2020; Krabokoukis & Polyzos, 2020; Kemeny & Storper, 2014).

Results and discussions

Table 1 presents the absolute number of firms in activity and the number of persons employed by those firms in 2019 and 2022 for the Portuguese economy. It also shows the variable growth rate from 2029 to 2022. In Portugal, the number of active businesses (individual or corporate businesses) in accommodation and food services represent 8.95% and 8.25% of all active registered companies in the economy in 2019 and 2022, respectively. The number of persons employed in the sector represents 9.45% and 9.08% for 2019 and 2022, respectively, of all persons engaged in active businesses in the Portuguese economy. Between 2019, the year before the pandemic, and 2022, the first year without any health constraints due to the pandemic, the number of active businesses grew by 9% in Portugal, while the businesses in accommodation and food services grew by 0.5%. Regarding the number of persons employed, the variable grew by 6.2% in the whole economy while the persons employed in accommodation and food services grew 3 times less – just 2%.

Table 1. Evolution of the number of active businesses and persons employed between 2019 and 2022 for the Portuguese economy

Portugal		Number of active businesses			Number of persons employed		
		2019	2022	%Δ (2022-2019)	2019	2022	%Δ (2022-2019)
All sectors	Nº	1 318 330	1 437 254	9,0	4 225 538	4 487 322	6,2
Accommodation and food services	Nº	118 031	118 620	0,5	399 241	407 255	2,0
	% Share	8,95	8,25	-----	9,45	9,08	-----

Source: Authors elaboration based on data from INE (2024)

Table 2 presents the number of active businesses and persons employed in each regional tourism division - for whole sectors and the accommodation and food services sector. Besides these numbers, it also presents the percentual share of each regional value in the full economy. The growth rate between 2019 and 2022 is presented. Additionally, the regional location quotient (and the respective growth rate) for the accommodation and food services sector can be observed before and after the global pandemic.

Table 2. Evolution of the number of active businesses, persons employed and the location quotient between 2019 and 2022 by regional tourism division

Regions / Sectors			Number of active businesses			Number of persons employed		
			2019	2022	%Δ (2022-2019)	2019	2022	%Δ (2022-2019)
Norte	All sectors	Nº (%Share)	446 149 (33,8)	483 345 (33,6)	8,3	1 418 707 (33,6)	1 505 045 (33,5)	6,1
	Accommodation and food services	Nº (%Share)	33 218 (28,1)	33 852 (28,5)	1,9	98 003 (24.5)	104 222 (25,6)	6,3
		LQ	0,83	0,85	2,0	0,73	0,76	4,4
Centro	All sectors	Nº (%Share)	269 110 (20,4)	287 203 (20,0)	6,7	759 243 (18,0)	791 188 (17,6)	4,2
	Accommodation and food services	Nº (%Share)	20 877 (17,7)	21 025 (17,7)	0,7	54 855 (13,7)	56 919 (14,0)	3,8
		LQ	0,87	0,89	2,4	0,76	0,79	3,7
LVT	All sectors	Nº (%Share)	382 504 (29,0)	426 928 (29,7)	11,6	1 482 870 (35,1)	1 578 834 (35,2)	6,5
	Accommodation and food services	Nº (%Share)	33 581 (28,5)	30 924 (26,1)	-7,9	152 960 (38,3)	148 145 (36,4)	-3,1
		LQ	0,98	0,88	-10,5	1,09	1,03	-5,3
Alentejo	All sectors	Nº (%Share)	86 189 (6,5)	90 600 (6,3)	5,1	221 387 (5,2)	239 457 (5,3)	8,2
	Accommodation and food services	Nº (%Share)	7 893 (6,7)	7 717 (6,5)	-2,2	18 370 (4,6)	18 722 (4,6)	1,9
		LQ	1,02	1,03	0,9	0,88	0,86	-1,9
Algarve	All sectors	Nº (%Share)	76 971 (5,8)	86 803 (6,0)	12,8	191 215 (4,5)	203 641 (4,5)	6,5
	Accommodation and food services	Nº (%Share)	15 664 (13,3)	17 784 (15,0)	13,5	48 546 (12,2)	50 554 (12,4)	4,1
		LQ	2,27	2,48	9,2	2,69	2,74	1,8
Açores	All sectors	Nº (%Share)	28 746 (2,2)	30 393 (2,1)	5,7	72 715 (1,7)	77 727 (1,7)	6,9
	Accommodation and food services	Nº (%Share)	2 863 (2,4)	3 071 (2,6)	7,3	9 107 (2,3)	9 906 (2,4)	8,8
		LQ	1,11	1,22	10,1	1,33	1,40	5,9
Madeira	All sectors	Nº (%Share)	28 661 (2,2)	31 982 (2,2)	11,6	79 401 (1,9)	91 430 (2,0)	15,1
	Accommodation and food services	Nº (%Share)	3 935 (3,3)	4 247 (3,6)	7,9	17 400 (4,4)	18 787 (4,6)	8,0
		LQ	1,53	1,61	4,9	2,32	2,26	-2,4

Source: Authors elaboration based on data from INE (2024)

The table allows us to observe the accommodation and food sector's unequal importance in the Portuguese tourism divisions. In 2019, the regions of Norte and LVT had the most significant share of active businesses in accommodation and food services (28.1% and 28.5%), followed by the Centro and Algarve regions with a share of 17.7% and 13.3%, respectively, of all businesses in the sector. The same pattern of shares appears when observing the number of persons employed. The accommodation and food services sector in LVT accounts for a share of 38.3% of all persons employed in the sector, while Norte accounts for 24.5%, Centro for 13.7% and Algarve 12.2%. The other regions present much smaller shares for both indicators. From a regional perspective, Portuguese regions present different growth rates for both indicators. The number of active businesses in the sector of accommodation and food services decreased in LVT (-8.4%) and Alentejo (-2.7%), presented a small increase rate in Centro (0.2%) and Norte (1.4%) and increased more than the whole economy (all sectors of activity) in Algarve (13.5%), Açores (7.3%) and Madeira (7.9%). The same pattern is observed regarding the growth rates for the number of persons employed in the sector.

Even if the percentual share of the accommodation and food activities is smaller in some regions compared with the regions of Norte and LVT, these regions are not where the sector is more concentrated. The LQ for the sector indicates the relevance of the regions of Algarve, Açores, and Madeira and, to a lesser extent, the Alentejo. This was true before the pandemic and became more pronounced after it. The Algarve is the most concentrated region regarding the number of active businesses and persons employed in the accommodation and food services sector, presenting growth rates of the LQ of 9.2 and 1.8%, respectively, between 2019 and 2022. Indeed, the Algarve is renowned globally for its sun and beaches, natural parks, and historical landmarks and has solidified its reputation as a premier tourist hotspot. Therefore, it became a vital region in the Portuguese tourism industry (Martins & Correia, 2024). However, its reliance on tourism makes it susceptible to crisis negative impacts making it more critical the ability to recover from them. The values calculated for the LQ show the region has been resilient in the accommodation and food services sector. Açores is another Portuguese region that demonstrates the same resilience.

Tables 1 and 2 indicate the effective change observed for the two indicators in the analysis, considering that a pandemic crisis dramatically hit the accommodation and food services sector between the two years observed. Table 2 also allows us to observe the effective change differed in different regions. Even though only the accommodation and food services sector is presented and compared with the whole economy, it is also possible to infer the changes in the sector differ from the economy and possibly from other sectors. Moreover, Table 2

shows the regions more concentrated in accommodation and food services remained the same after the pandemic, indicating no change in the specialisation regional patterns in this sector. So, to go further in the analysis, the shift-share analysis is applied to the data to explore the structural changes in a sector within regional areas over a designated period.

Table 3 presents the results of the shift-share analysis of the existing active businesses operating in Portugal and the persons employed in those businesses, respectively. In the table, it is possible to observe the growth rates concerning the national, sectoral and regional components of the shift-share analysis. The national share component (NS) corresponds to the growth rate of each indicator for the whole Portuguese economy independently of the regions that compose it or the type of economic sectors. The sectorial component of the shift-share analysis (the sectoral mix component = SM) considers the 17 major sections of the Portuguese Classification of Economic Activities (CAE Revision 3). Finally, the regional shift component (RS) is reflected in the indicator's growth rates in the seven regional tourism divisions that compose the Portuguese economy. The regional shifts component is presented only for the total growth rate for each indicator and the indicator's growth rate for the accommodation and food services activities. The Portuguese economy's effective (real) growth rate, the total shift component (TS), is calculated by summating the total regional, sectoral, and national components. In Table 3, only the accommodation and food services sector is presented when showing the regional results. So, the effective growth rate for the accommodation and food services sector is equal to the sum of the value computed for the sector's regional component, the value computed for the sector's sectoral component, and the value calculated for the national component.

As Tables 1 and 2 show, the number of active businesses in the Portuguese economy increased from 2019 (the year before the world pandemic) to 2022 growth of 9.0%. The number of people in service in those firms grew by 6.2%. These values do not depend on the Portuguese NUT III administrative regions or the sector of activity in which firms are operating, or persons are employed. Even though for the whole Portuguese economy, there was a rise in the number of businesses in activity, if each sector of activity is taken individually (sectoral component), the surge did not happen in all 17 main sectors of activity. Active businesses decreased in eight activity sectors, including the accommodation and food services sectors. The businesses in activity in the Portuguese economy's accommodation and food services sector, as a whole, in 2022 decreased by 8.52%. The same happens for the indicator that measures the number of persons employed. For the accommodation sector, the number decreased by 4.19% in the whole Portuguese economy.

Table 3. Results of the shift-share analysis

Portugal	NS = National Share Component (%)	
	Active businesses	Persons employed
	9,00	6,20
Sectors of activity	**SM = Sectoral Mix Component (%)**	
	Active businesses	**Persons employed**
Agriculture and fishing	-14,39	-4,59
Mining and quarrying	-10,20	-1,50
Manufacturing	-9,50	-6,67
Electricity, gas, steam and air conditioning supply	29,24	12,71
Water supply; sewerage, waste management and remediation activities	-10,09	5,37
Construction	4,29	6,62
Wholesale and retail trade; repair of motor vehicles and motorcycles	-9,60	-4,08
Transportation and storage	28,15	0,13
Accommodation and food service activities	-8,52	-4,19
Information and communication	30,55	26,83
Real estate activities	14,50	14,54
Professional, scientific and technical activities	4,10	6,85
Administrative and support service activities	8,08	1,45
Education	-0,19	2,38
Human health and social work activities	5,86	2,80
Arts, entertainment and recreation	6,67	8,80
Other service activities	-0,20	-3,10

Regions	RS = Regional Shift Component (%)				TS = Total Shift Component (%)			
	Active businesses		Persons employed		Active businesses		Persons employed	
	Total	Accommodation and food services	Total	Accommodation and food services	Total	Accommodation and food services	Total	Accommodation and food services
Norte	-0,68	1,41	-0,11	4,34	8,3	1,91	6,09	6,35
Centro	-2,30	0,21	-1,99	1,76	6,7	0,71	4,21	3,76
LVT	2,59	-8,41	0,28	-5,16	11,6	-7,91	6,47	-3,15
Alentejo	-3,90	-2,73	1,97	-0,09	5,1	-2,23	8,16	1,92
Algarve	3,75	13,04	0,30	2,13	12,8	13,53	6,50	4,14
Açores	-3,29	6,77	0,70	6,77	5,7	7,27	6,89	8,77
Madeira	2,57	7,43	8,95	5,96	11,6	7,93	15,15	7,97

Source: Authors elaboration based on data from INE (2024)

Going deep into the analysis and doing it by regions, it is possible to observe the decrease in the number of active businesses in the accommodation sector and the number of persons on service behaving differently by regional tourism divisions. The accommodation and food services sector grew intensively, regarding the number of active businesses in areas like the Algarve (13.04%),

Madeira (7.43%), Açores (6.77%) and to a minor extent in Norte (1.41%) and Centro (0,21%). Two regions observed a decline in active businesses in the sector (LVT and Alentejo), with the region of LVT concentrating the most significant number of firms. It is clear from the table's observation that the full Portuguese economy was much more resilient after the pandemic than the accommodation and food services activities if only the activity sectors are considered (the sectoral mix in the shift-share analysis).

The opposite evolution observed between the economy's growth rates and the sector's growth is more pronounced for active businesses operating in the accommodation and food services activities than for the number of persons employed. The Portuguese national positive trend seemed to be driven by sectors such as electricity, gas, steams and air conditioning, transportation and storage, information and communication, real estate and administration, health and entertainment activities regarding the active businesses operating in the economy and the number of persons employed even if in a less extent.

Despite the negative evolution in the sectoral mix, for the accommodation and food services sector, the regional component was able to balance the sector's growth and leverage it to increase the effective growth rate observed between 2019 and 2022. Indeed, except for the region of LVT (and Alentejo for the case of the number of persons employed), the accommodation and food services sector outperformed the entire economy better in all regions if only the regional component was considered. Such good regional performance and the growth trend observed for the Portuguese economy during this period allowed the accommodation and food services sector to recover from the negative effects of the sector.

Innovation seems to be an important driving force for Portuguese regional resilience in the aftermath of the pandemic crisis. Regions where R&I entities engaged in innovation co-creation projects together with business partners were more resilient in the recovery phase. It is, therefore, important that policymakers adopt mechanisms to stimulate stronger collaboration between regional stakeholders, favouring the transference of knowledge, competencies, and technology (Sargento & Lopes, 2024). The authors also found that regional structural characteristics play different roles during the phases of resistance and recovery after the pandemic. Sectoral diversity and a more qualified labour force are important for mitigating the immediate impact of the crisis but do not appear to be crucial for the recovery of Portuguese regions. Additionally, labour stability helps reduce the shift from employment to unemployment during crises, while some flexibility is needed in the recovery stage to facilitate the transition back to employment (Sargento & Lopes, 2024). Such explanation may explain the regional results for the accommodation and food services when comparing

the evolution of variable persons employed in the sector to the variable numbers of active businesses operating in the sector. In the regions where the regional growth was more evident for the active business, the numbers of persons employed did not perform so well.

A recent study on the future of Portuguese tourism and hospitality labour based on the sector's key stakeholders' opinions states that "the most prominent challenges that the COVID-19 pandemic created are the damage to practical ability, finding a skilled and experienced workforce, and attracting tourism labour back to the sector" (Seyitoğlu et al., 2023, p. 1). The authors state that medium and long-term measures are needed to overcome such challenges in the future. They suggest the development of future trends and skills for tourism and hospitality employment together with new working models, digitisation and robotisation, and skills such as management, analytical, digital marketing, and customer behaviour analysis.

The shift-share analysis helps distinguish between the growth attributed to the national economic cycle and the growth due to regional competitive advantages. Understanding where a region stands out can inform strategies to enhance its appeal and competitiveness, as the Algarve, Madeira, or Açores regions stand out in the observed growth of the accommodation and food services sector and could be defined as a benchmark against broader national trends. Note that Algarve and Madeira represent well-established tourist destinations with high demand, while the Azores, recently recognized as Europe's leading adventure tourism destination, exemplify regions experiencing rapid tourism growth with sound location quotients for the sector.

Literature stresses that accommodation and food services managers should consider highlighting the competitive advantages of destinations and the unique supply proposals. By doing so, they can attract and retain visitors, even during challenging times like a pandemic. Emphasising these strengths can mitigate the adverse effects of such crises, making the destinations and products more appealing and resilient in the market (Afonso & Calisto, 2023). Moreover, several lessons can be learned from regions that outperform the shift-share analysis, as in the case of Açores. The region diversified tourism offerings, promoted domestic and regional tourism, prioritised sustainable development, embraced digital tools, prepared for emergencies, fostered business collaboration, invested in health and safety measures, involved local communities and adopted a long-term vision (Sousa et al., 2023). Sustainable innovation in tourism has brought positive changes in the Algarve region's natural resources, economy, urban planning, safety, and monitoring, which has allowed it to generate employment, create businesses, and increase tourist outflows. Moreover, sector diversification may drive a regional resilience enhancement - beyond the sun

and sea tourism specialisation in the Algarve region - supported by sustainable touristic products like nature-based, cultural, and creative tourism products (Martins & Correia, 2024; Samora-Arvela et al., 2024). The same strategy also seemed to work for Madeira. In the aftermath of the pandemic, Madeira bet on the strategy to develop promotional activities in various international markets and foster sustainable tourism – namely the certification of the archipelago as a sustainable tourist destination. This approach secured sociocultural identity and authenticity while providing socio-economic benefits for all stakeholders (Jesus, 2023), helping the recovery of tourism-related activities.

Conclusions

While the Portuguese economy experienced growth between 2019 and 2022, despite the pandemic, the accommodation and food services sector did not fare as well when examined in isolation. The sector faced an 8.52% drop in active businesses and a 4.19% reduction in employment, diverging from the general positive trends in other sectors of the economy. However, certain regions, notably Algarve, Madeira, and Açores, showed strong recovery and growth within this sector. These regions benefitted from their robust tourism appeal, measured by their location quotient, and proactive regional policies, which gave them a competitive edge. Regions with a more diverse economic organisation were better equipped to handle the immediate impacts of the pandemic and support recovery, highlighting the importance of economic diversity for resilience. Innovation seems to play a crucial role in regional recovery. Areas encouraging collaboration between research institutions, innovation entities, and businesses fared better, suggesting that policies promoting knowledge and technology transfer can significantly bolster regional resilience. The study indicates that regional and industrial factors were more influential than national economic growth in shaping the post-pandemic landscape of Portugal's accommodation and food services sector. It should be noticed, however, that the analysis highlights the role of regional policies but does not delve deeply into specific policy measures and their direct impact on the sector. A more detailed policy impact analysis could enhance the understanding of effective strategies

It is important to remember that the shift-share analysis methodology used is exploratory rather than explanatory, which is a limitation of the present research. Even though by identifying the regional component of growth, businesses and policymakers can understand the unique competitive advantages or disadvantages of a region's accommodation and food services sector. This insight is crucial for developing strategies to enhance competitiveness, such as

improving service quality, diversifying offerings, or investing in marketing. For investors and policymakers, shift-share analysis helps identify high-potential areas for investment or development within the accommodation and food services sectors. By understanding which regions or sub-sectors outperform due to intrinsic factors, resources can be allocated more effectively to maximise economic returns and job creation.

Given that this research analysis is exploratory rather than explanatory, further research is recommended over a more extended timeframe. This should include other tourism-related sectors and a detailed policy effectiveness analysis. Such an approach would better capture long-term recovery trends and the sustainability of the sector's growth post-pandemic. It would also provide a comprehensive view of the overall tourism industry's recovery and its interdependencies and offer a detailed analysis of specific policy interventions and their effectiveness across different regions. This information would be crucial for guiding future policy-making and strategic planning.

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REFERENCES

Afonso, V. & Calisto, M.L. (2023). Covid-19 and the Portuguese accommodation sector. *European Journal of Tourism, Hospitality and Recreation*, 13(1), 49-55. https://doi.org/10.2478/ejthr-2023-0005

Artige, L. & van Neuss, L. (2014). A new shift-share method. *Growth and Change*, 45(4), 667–683, https://doi.org/10.1111/grow.12065

Benítez-Aurioles, B. (2020). Tourism resilience patterns in Southern Europe. *Tourism Analysis*, 25(4), 409-424. https://doi.org/10.3727/108354220X16010020096118

Benítez-Aurioles, B. (2022). Análisis regional del mercado peer-to-peer de alojamientos turístico en España durante la pandemia. *ROTUR. Revista de Ocio y Turismo*, 16(2), 112-134. https://doi.org/10.17979/rotur.2022.16.2.8889

Broxterman, D.A. & Larson, W.D. (2020). An empirical examination of shift-share instruments. *Journal of Regional Science*, 60(4), 677-711. https://doi.org/10.1111/jors.12481

Cheng, S. (2011). Business cycle, industrial composition, or regional advantage? A decomposition analysis of new firm formation in the United States. *Annals of Regional Science*, 47(1), 147–167. https://doi.org/10.1007/s00168-009-0361-0.

Colmekcioglu, N., Dineva, D. & Lu, X. (2022). "Building back better": the impact of the COVID-19 pandemic on the resilience of the hospitality and tourism industries. International *Journal of Contemporary Hospitality Management*, 34(11), 4103-4122. https://doi.org/10.1108/IJCHM-12-2021-1509

Costantino, S., Cracolici, M.F. & Piacentino, D. (2021). A new spatial shift-share decomposition: An application to tourism competitiveness in Italian regions. *Geographical analysis*, 53(4), 708-735. https://doi.org/10.1111/gean.12262

Dogru, T. & Sirakaya-Turk, E. (2017). Engines of tourism's growth: an examination of efficacy of shift-share regression analysis in South Carolina. *Tourism Management*, 58, 205–214, https://doi.org/10.1016/j.tourman.2016.10.021.

Dogru, T., Suess, C., & Sirakaya-Turk, E. (2021). Why do some countries prosper more in tourism than others? Global competitiveness of tourism development. *Journal of Hospitality & Tourism Research*, 45(1), 215-256. https://doi.org/10.1177/1096348020911706

Dogru, T., McGinley, S., Sharma, A., Isık, C. & Hanks, L. (2023). Employee turnover dynamics in the hospitality industry vs. The overall economy. *Tourism Management*, 99, 104783. https://doi.org/10.1016/j.tourman.2023.104783

Dunn, E. S. (1960). A statistical and analytical technique for regional analysis. *Papers and Proceedings of the Regional Science Association*, 6(1), 97–112. https://doi.org/10.1111/j.1435-5597.1960.tb01705.x

Esteban, J. (2000). Regional convergence in Europe and the industry mix: a shift-share analysis. *Regional Science and Urban Economics*, 30(3), 353–364. https://doi.org/10.1016/ S01660462(00)00035-1.

Fernando, I.N. (2020). Tourism competitiveness by shift-share analysis to way-forward Destination Management: A case study for Sri Lanka. *Journal of Tourism and Services*, 11(21), 88-102. https://doi.org/10.29036/jots.v11i21.139

Goschin, Z. (2014). Regional growth in Romania after its accession to EU: a shift-share analysis approach. *Procedia Economics and Finance*, 15, 169–175. https://doi.org/ 10.1016/S2212-5671(14)00471-7

Huang, S.S. & Wang, X. (2023). COVID-19 two years on: a review of COVID-19-related empirical research in major tourism and hospitality journals. International *Journal of Contemporary Hospitality Management*, 35(2), 743-764. https://doi.org/10.1108/IJCHM-03-2022-0393

INE, 2024. INE, Demografia das empresas. [Online]. Available at https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_base_dados

Irving, J., Waters, K., Clower, T. & Rifkin, W. (2023). Pandemic regional recovery index: An adaptable tool for decision-making on regions. In Celbiş, M.G., Kourtit, K., Nijkamp, P. (Eds) *Pandemic and the City. Footprints of Regional Science*. Springer, Cham. 237-260. https://doi.org/10.1007/978-3-031-21983-2_13

Jesus, E. (2023). Madeira tourism—always proactive toward sustainability. *Worldwide Hospitality and Tourism Themes*, 15(6), 664-668. https://doi.org/10.1108/WHATT-09-2023-0114

Kemeny, T., & Storper, M., (2014). Is Specialization good for regional economic development? *Regional Studies*, 49(6), 1003–1018. https://doi.org/10.1080/00343404.2014.899691

Krabokoukis, T. & Polyzos, S. (2021). Spatial inequalities of tourist activity in Greece: a shift-share analysis. *Anatolia*, 32(1), 93-105. https://doi.org/10.1080/13032917.2020.1851271

Lopes, A.S., Sargento, A. & Carreira, P. (2021). Vulnerability to COVID-19 unemployment in the Portuguese tourism and hospitality industry. *International Journal of Contemporary Hospitality Management*, 33(5), 1850-1869. https://doi.org/10.1108/IJCHM-11-2020-1345

Martins, P. & Correia, A. (2024). Beyond sun and sand: How the Algarve Region is pioneering innovative sustainable practices in tourism. In Pechlaner, H., Innerhofer, E., & Philipp, J. (Eds.) *From Overtourism to Sustainability Governance: A New Tourism Era.* Routledge. 47-58. https://doi.org/10.4324/9781003365815_8

Nyagadza, B., Chigora, F., Pashapa, R., Chuchu, T., Maeeresa, W. & Katsande, C. (2022). Effects of COVID-19 on tourism and hospitality: Exploring the new normal. In Mohanty, P., Sharma, A., Kennell, J. & Hassan, A. (Eds.) *The Emerald Handbook of Destination Recovery in Tourism and Hospitality*, Emerald Publishing Limited. 11-21. https://doi.org/10.1108/978-1-80262-073-320221002

Provenzano, D. & Baggio, R. (2020). Quantitative methods in tourism and hospitality: a perspective article. *Tourism Review*, 75(1), 24-28. https://doi.org/10.1108/TR-07-2019-0281

Rodríguez-Antón, J.M. & Alonso-Almeida, M.M. (2020). COVID-19 impacts and recovery strategies: The case of the hospitality industry in Spain. *Sustainability*, 12(20), 8599. https://doi.org/10.3390/su12208599

Samora-Arvela, A., Pinto, P., Panagopoulos, T., Vaz, E., Ferreira, J., Pina, H. & Pinto, D.M. (2024). Regional resilience and dependence on tourism in a changing climate. In Remoaldo, P., Lopes, H., Ribeiro, V., Alves, J. (Eds.), *Tourism and Climate Change in the 21st Century. Advances in Spatial Science.* Springer. 117-142. https://doi.org/10.1007/978-3-031-59431-1_6

Sanabria-Díaz, J.M., Aguiar-Quintana, T. & Araujo-Cabrera, Y. (2021). Public strategies to rescue the hospitality industry following the impact of COVID-19: A case study of the European Union. *International Journal of Hospitality Management*, 97, 1029988. https://doi.org/10.1016/j.ijhm.2021.102988

Santos, L.D. & Vieira, A.C. (2020). Tourism and regional development: a spatial econometric model for Portugal at municipal level. *Portuguese Economic Journal*, 19, 285–299. https://doi.org/10.1007/s10258-020-00179-z

Saputra, P.M.A. (2023). COVID-19 and tourism industry: An investigation of spatial dependence in Europe. *Cogent Social Sciences*, 9(2). https://doi.org/10.1080/23311886.2023.2282413

Sargento, A. & Lopes, A.S. (2024). Territorial resilience on the aftermaths of COVID-19 crisis - An exploratory analysis on the role of innovation. *Regional Science Policy & Practice*, 16(1), 12697. https://doi.org/10.1111/rsp3.12697

Seyitoğlu, F., Costa, C., Martins, M. & Malta, A.M. (2023). The future of tourism and hospitality labour: challenges, requirements, trends, skills and the impact of technology. *Current Issues in Tourism*, 1–15. https://doi.org/10.1080/13683500.2023.2286291

Sobaih, A.E.E., Elshaer, I., Hasanein, A.M. & Abdelaziz, A.S. (2021). Responses to COVID-19: The role of performance in the relationship between small hospitality enterprises' resilience and sustainable tourism development. *International Journal of Hospitality Management*, 94, 102824. https://doi.org/10.1016/j.ijhm.2020.102824

Sousa, Á., Macedo, B., Couto, G. & Castanho, R.A. (2023). Effects of COVID-19 on the Tourism Sector: Learning from the Azores Islands. *Sustainability*, 15(18), 13339. https://doi.org/10.3390/su151813339

Tunio, M.N., Yusrini, L., Shah, Z.A., Katper, N. & Jariko, M.A. (2021). How hotel industry cope up with the COVID-19: An SME Perspective. *Etikonomi*, 20(2), 213-224. https://doi.org/10.15408/etk.v20i2.19172.

Turismo de Portugal (2024). O Turismo em Portugal: Factos e Números. [Online] Available at: https://www.turismodeportugal.pt/pt/quem_somos/Organizacao/information-hub-mne/Paginas/turismo-em-portugal-factos-e-numeros.aspx

Utkarsh & Sigala, M. (2021). A bibliometric review of research on COVID-19 and tourism: Reflections for moving forward. *Tourism Management Perspectives*, 40, 100912. https://doi.org/10.1016/j.tmp.2021.100912

Wheeler, J.O. (2005). Geography. In Kempf-Leonard, K. (Ed). *Encyclopedia of Social Measurement*. Elsevier. 115-123. https://doi.org/10.1016/B0-12-369398-5/00277-2

World Travel & Tourism Council [WTTC] (2023). Economic Impact Report 2023: Global Trends. [Online] Available at https://researchhub.wttc.org/product/economic-impact-report-2023-global-trends

Yasin, M., Alavi, J., Sobral, F. & Lisboa, J. (2004). A shift-share analysis approach to understanding the dynamic of the Portuguese tourism market. *Journal of Travel & Tourism Marketing*, 17(4), 11-22. https://doi.org/10.1300/J073v17n04_02

Ye, H., Chan, I.C.C. & Law, R. (2023). A systematic review of initial COVID-19 research in tourism and hospitality. *Tourism Analysis*, 28(1), 125-141. https://doi.org/10.3727/108354222X16630748399737

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WHAT MAKES A BRAND SUCCESSFUL? - A CASE STUDY OF THE MUSETTE BRAND

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ABSTRACT. The study of gender differences has recently become a growing focus. Nothing is more evidence of this than the fact that in 2023 Claudia Goldin (who studied the position of women in relation to the labour market) was awarded the Nobel Prize in Economics. Furthermore, internationally, there are numerous studies that examine the differences between women and men as leaders and managers. The question arises as to what factors play a significant role from the perspective of women managers in starting and managing a successful business. The present research focuses on the analysis of a Romanian brand - Musette[3] - which is co-founded by a woman (through Cristina Bâtlan) and is represented internationally. Despite the considerable success of the Musette brand, there is a lack of literature in Romania on the study of this brand[4]. Consequently, the objectives of our study are[5]: (1) to identify the conditions that should be the pillars of a start-up business, (2) to identify the factors without which there is no possibility of further development and lasting success, and (3) to examine the brand personality characteristics of Musette.

Keywords: female managers, market, employee, communication, brand personality
JEL classification: M10, M31

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[3] Is one of the most known brand in shoes and handbags business industry in Romania.
[4] Cojocaru mentions the brand and its success in a 2014 study.
[5] In our opinion, the familiarization of domestic brands and their promotion among students through various didactic methods can be identified as a primary pedagogical objective.

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Introduction and review of literature

Society's perception of women has taken many different forms throughout history. Today it seems almost incomprehensible, but there was a time when the only activity women could do in public was shopping (Törőcsik, 2006). Moreover, there were periods in history when the position of women as workers and managers was unintelligible. One need only think of the significant statement in the film based on Agatha Christie's novel *The Case of the Missing Will*: "Oh, if I were a man, I'd get a loan tomorrow", from the bank. According to one of the male characters, this phenomenon can be explained by the evidence that: "Women in business would always be begging for discounts". In response to the above dialogue, Captain Hastings hesitantly remarks: "Well, I don't know many women in business life". It is a fact that the position of women as leaders and managers is extremely complex nowadays: it is therefore important to understand what characterises the communication of women entrepreneurs and to identify the specific factors that play a significant role in female-led businesses.

As a starting point, it is worth noting that firms with a more diverse workforce (in terms of ethnicity and gender) perform better financially (Hunt et al., 2015), despite the fact that women are not better managers than men, and vice versa. However, due to their psychological, gender differences, women have different skills and leadership styles (Merchant, 2012).

One of the characteristics of female leaders is that they weigh their self-image in the context of relationships, which suggests that female leaders have a more interactive leadership style that serves to create a sense of belonging (Karim et al., 2022): this form of expression can also be found in their everyday communication, as "they are better able to convey the message to their partner through posture, movement, eye contact: I am listening to you, I care about you, I am interested in what you have to say" (Huszár, 2014, p. 21). In relation to their communication at work, women are more likely to have "an expressive style of communication as they will be able to confide in others and are more sensitive to issues than men women will be able to build, maintain and strengthen the relationship" (Mohindra & Azhar, 2012, p. 27). However, in business, they prefer to use text messaging, social media and online video calls (Kimbrough et al., 2013), i.e. they are more likely to take advantage of the online space for communication, while male leaders, conversely, prefer face-to-face forms of communication (Tench,

2017). Moreover, female entrepreneurs tend to use more specific language when describing their businesses than their male counterparts (Huang et al., 2021), and they also communicate their successes differently (Grant & Taylor, 2014). The way women managers communicate is shaped by the context and the roles (woman, mother, wife) in which they appear (Netshitangani, 2008), as their communication reflects how family and career can be compatible and synchronised, thus setting an example (Zeler et al., 2022). It is also important for them to communicate that they are members of the team and not above the team (Timko, 2017), but interestingly, when women adopt a more masculine communication, they are perceived as less sympathetic (von Hippel et al., 2011).

Material and methods

This research is based on one of the typical methods of quantitative marketing research, namely observation, including content analysis. Prior to the content analysis, a Google search engine was used to search for content related to Cristina Bâtlan[6].

From the content displayed, the communication technique chosen was the one in which Cristina B. personally tells - at length - about herself as an entrepreneur and manager. Consequently, the content analysis was based on the following podcast: Cristina Bâtlan, a lioness who built an empire: At home with Măruță [Cristina Bâtlan, o leoaică ce a construit un imperiu: Acasă la Măruță].

The podcast

- date of release: 10th April 2022.
- 825,102 views at data collection period.
- duration: 2:56:10[7].

The content analysis was carried out according to the following research questions:

a. What are the criteria that should be the main pillars of a start-up business?
b. On which variables can Musette be analysed in the market?
c. What characterises Musette's management?
d. According to which criteria - in the case of the Musette brand - is the employee approach based on?

[6] Cristina B.'s work is also worth studying because she appears as the only female investor in the 'Empire of Lions', between 2021-2023, and she is a big fan of female entrepreneurs in the Chapters series events.

[7] The podcast can be accessed at: https://www.youtube.com/watch?v=BejCPA7SRCk (April 2023).

The content analysis was followed by an analysis of the viewers' comments on the podcast, with reference to the research question: What are the human qualities that define Cristina B. and that are also the personality characteristic of the Musette brand?

The following points should be noted about the audience reviews:

- A total of 650 reviews were written about the podcast at the time the data was collected[8].
- Once the personality characteristics had been identified, they were structured, as the respondents used several synonyms to express the same personality characteristic. However, it is also worth noting that there were instances where commentators used the same concepts identified by Jennifer Aaker (1997, in Kotler & Keller, 2006) as brand personality characteristics. These are: intelligent, reliable, upper class, charming, down-to-earth, daring, honest.
- Audience reviews were collected and categorized between 10 April 2023 - 11 April 2023.

Results and discussions

The figure below (Figure 1) summarises all the criteria that the entrepreneur considers necessary to create a viable business. In Cristina B.'s opinion, (1) awakening latent needs, (2) creating a better quality product portfolio and (3) managing the challenges posed by changes in the macro-environment in such a way that they have a positive impact on the target segment are cardinal points in the life cycle of a business. It should be noted that a business can only create long-term added value in both directions (micro and macro) if it makes investments that are in harmony with the values it communicates, and therefore the application of ethics in business is more than necessary (Figure 1).

According to Cristina B., the relevance of the following is indisputable for entities that want to achieve significant results in business:

- ✓ The need to listen to inner instincts, the need for autonomy.
- ✓ A belief in ideas, in enterprise, in the impossible.
- ✓ The process of selecting stakeholders.
- ✓ Continuous analysis of the market in order to identify the needs of consumers.
- ✓ Holistic knowledge of consumers.

[8] Note that the proportion of negative comments was negligible.

Figure 1. The pillars of a successful brand as seen by Cristina B.
Source: own, based on the pitches observed: podcast Cristina Bâtlan, a lioness who built an empire: At home with Măruță

- ✓ The application of relationship marketing.
- ✓ Following trends.
- ✓ Avoiding long-term planning: customer behaviour changes in 6 months.
- ✓ Use of the JIT system.
- ✓ Creativity.
- ✓ Flexibility.
- ✓ Redefining strategies.
- ✓ Interpreting and using information appropriately.
- ✓ The curious, inquisitive nature of the entrepreneur.
- ✓ Preparing for a potential opportunity.
- ✓ Taking significant risk, as this can lead to greater success.
- ✓ Anticipating failure. Learning from mistakes. Formulating conclusions and building on them.

- ✓ Hiring skilled people, because they are the real value. Corporate success comes from its employees. People have value, money is less important. For employees, appreciation is more important than any financial incentive.
- ✓ Increasing expertise, continuous learning from young people as well as from seniors.

As noted above, the interdependency between market, management and employees is the corporate entity without which there is no development (Figure 2).

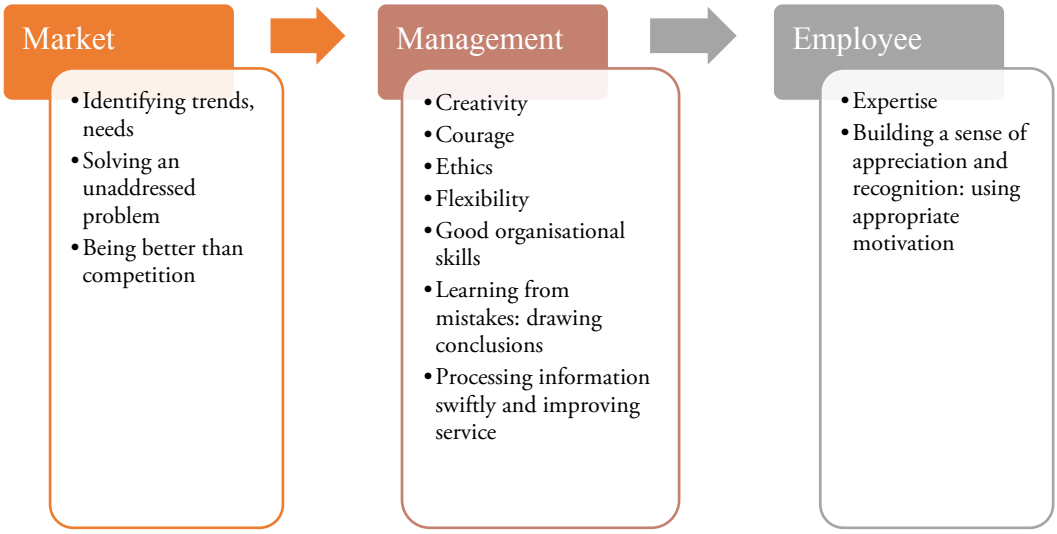

Figure 2. "Three in a pair", or the triad of market, management and employees
Source: own, based on the pitches observed: podcast Cristina Bâtlan, a lioness who built an empire: At home with Măruță

As noted in the literature, consumers see the brand through the human resource (Olins, 2010) also implicitly through the owner, the manager. His/her behaviour and communication play a significant role in creating the brand identity. What is more, the personality traits that define the brand representatives are transformed into brand characteristics. Consequently, a brand can also be sincere, exciting competent, sophisticated, rugged (Kotler & Keller, 2006).

The following is a summary of the personality traits that are specific to Cristina B. and are also personality characteristics of the Musette brand.

(1) Sincerity: down-to-earth, honest, healthy[9], optimist[10],
(2) Excitement: daring, dynamic[11], imaginative[12], modern[13],
(3) Competence: reliable, intelligent[14], successful[15],
(4) Sophisticated: upper class, charming[16],
(5) Ruggedness: tenacious[17], active[18].

Conclusions

Our analyses are consistent with:

(1) with Karim et al., (2022), concluding: in the podcast, Cristina B. also refers to her employees as peers, with respect and appreciation, reflecting on the power of belonging.
(2) with Netshitangani's (2008), opinion: Cristina B. answered the questions proposed during the podcast as a woman, as a mother, as a (former) wife.
(3) with the remarks of Merchant (2012): during the podcast, Cristina B. set an intimate, personal tone, sharing information that was very personal, and reflected her personal qualities: promoting a different approach and leadership style.
(4) with the conclusions of Zeler et al. (2022): Cristina B. was identified as an inspiring example by several people who expressed their opinion on the podcast.

According to the podcast, the success of the Musette brand relies on the corporate philosophy, as it is fundamentally determined by the management's belief in (a) constantly monitoring the macro environment, (b) monitoring consumer needs and (c) managing employees. It is worth noting that sincerity is a brand personality characteristic without which there can be no long-term planning, as it activates and helps to build and maintain customer loyalty.

9 healthy mentality
10 happy
11 willingness/desire to act
12 special, interesting
13 open-minded
14 in addition to the notion of intelligent, the comments also included the concepts such as: clever, complex thinking, wise
15 mentor, role model, etalon, model, idol, inspiring, motivating, remarkable
16 in addition to the term charming, the comments also included: very beautiful, beautiful, wonderful, brilliant, magnificent, fabulous, dazzling, enchanting, elegant
17 strong, persistent
18 diligent

REFERENCES

Cojocaru, F.-G. (2014). Women entrepreneurship - A solution for Romanian economy development, *Management Strategies Journal*, 26(4), 555-562. Available at: https://ideas.repec.org/a/brc/journl/v26y2014i4p555-562.html

Grant, A. D. & Taylor, A. (2014). Communication essentials for female executives to develop leadership presence: Getting beyond the barriers of understating accomplishment. *Business Horizons*, 57(1), 73-83. https://doi.org/10.1016/j.bushor.2013.09.003

Huang, L., Joshi, P., Wakslak, C. & Wu, A. (2021). Sizing up entrepreneurial potential: Gender differences in communication and investor perceptions of long-term growth and scalability. *Academy of Management Journal*, 64(3), 716-740. https://doi.org/10.5465/amj.2018.1417

Hunt, V., Layton, D. & Prince, S. (2015). Diversity matters. *McKinsey & Company.* Available at: https://www.mckinsey.com/insights/organization/~/media/2497d4ae4b534ee89d929cc6e3aea485.ashx

Huszár, Á. (2014). Gender and communication: communication in the workplace. The differences, or who is better? [A gender és a kommunikáció összefüggései: kommunikáció a munkahelyen A különbségek, avagy ki a jobb?]. *Economica*, 7(4), 7-12. https://doi.org/10.47282/ECONOMICA/2014/7/4/4353

Karim, A., Syamsuddin, I., Jumarding, A. & Amrullah, A. (2022). The effect of gender independence and leadership style on audit quality in Makassar Public Accounting Offices. *International Journal of Social Science Research and Review*, 5(7), 114-126. https://doi.org/10.47814/ijssrr.v5i7.341

Kimbrough, A. M., Guadagno, R. E., Muscanell, N. L. & Dill, J. (2013). Gender differences in mediated communication: Women connect more than do men. *Computers in Human Behavior*, 29(3), 896-900. https://doi.org/10.1016/j.chb.2012.12.005

Kotler, P. & Keller, K. L. (2006). *Marketingmenedzsment* [*Marketing management*], Akadémiai Publishing House, Budapest.

Merchant, K. (2012). How men and women differ: Gender differences in communication styles, influence tactics, and leadership styles, *CMC, Senior Theses.* Available at: https://scholarship.claremont.edu/cgi/viewcontent.cgi?article=1521&context=cmc_theses

Mohindra, V. & Azhar, S. (2012). Gender communication: A comparative analysis of communicational approaches of men and women at workplaces. *IOSR Journal of Humanities and Social Science*, 2(1), 18-27. https://doi.org/10.9790/0837-0211827

Netshitangani, T. (2008). Gender differences in communication styles: The impact on the managerial work of a woman school principal. In *Comunicación presentada en ANZCA08 Conference: Power and Place. Wellington, Nueva Zelanda. Recuperado el* (Vol. 20). Available at: https://citeseerx.ist.psu.edu/document?repid=rep1&type=pdf&doi=e3c516aebe220111ed2d2c1c3fa6ac6ff171975b

Olins W. (2010), *Despre brand* [*About brands*], 2nd Edition, Publisher Comunicare.ro., București.

Tench, R., Topić, M. & Moreno, A. (2017). Male and female communication, leadership styles and the position of women in public relations. *Interactions: Studies in Communication & Culture*, 8(2-3), 231-248. https://doi.org/10.1386/iscc.8.2-3.231_1

Timko, K. (2017). Gender, communication styles, and leader effectiveness, *MPRA Paper*, https://mpra.ub.uni-muenchen.de/77021/1/MPRA_paper_77021.pdf

Törőcsik, M. (2006). *Consumer behaviour trends [Fogyasztói magatartástrendek]*, Akadémiai Publishing House, Budapest.

von Hippel, C., Wiryakusuma, C., Bowden, J. & Shochet, M. (2011). Stereotype threat and female communication styles. *Personality and Social Psychology Bulletin*, 37(10), 1312-1324. https://doi.org/10.1177/0146167211410439

Zeler, I., Fuentes-Lara, C. & Moreno, Á. (2022). Female leadership in communication management in Spain: making a difference in a sexist culture. *Corporate Communications: An International Journal*, 27(5), 74-92. https://doi.org/10.1108/CCIJ-04-2022-0047

*** The movie: *The Case of the Missing Will*, based on the novel written by Agatha Christie, https://www.youtube.com/watch?v=7aAkSNMaRCQ. At 00:9:57 of the film those statements can be heard, which are presented in the *Introduction* and *Review of Literature* sections.

The podcast: Cristina Bâtlan, a lioness who built an empire: At home with Măruță [Cristina Bâtlan, o leoaică ce a construit un imperiu: Acasă la Măruță], https://www.youtube.com/watch?v=BejCPA7SRCk

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PROSPECTS, CHALLENGES, AND IMPLICATIONS OF DEPLOYING ARTIFICIAL INTELLIGENCE IN TAX ADMINISTRATION IN DEVELOPING COUNTRIES

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ABSTRACT. Artificial intelligence (AI) can help transform tax administration in developing countries by automating certain functions, pinpointing patterns and irregularities, and forecasting future tax collections. AI can enhance the effectiveness, efficiency, and tax justice in tax administration. This paper discusses the development and deployment of AI in tax administration in developing countries. This paper outlines different AI technologies, the opportunities and challenges of using AI in tax administration, and the possible implications. The paper established that there is an increasing interest in harnessing AI in tax administration in developing countries. The challenges of deploying AI include a lack of quality data, inadequate technical expertise, and a paucity of clear legal and regulatory frameworks to govern the application of AI. The benefits of AI in tax administration were found to encompass increased tax revenue mobilisation and the attainment of sustainable development goals. Reduction in corruption, improved tax compliance, reduced tax avoidance and evasion among other benefits. The paper recommends that policymakers and tax authorities in developing countries improve data quality to support AI adoption, invest in AI research, innovation and development while supporting training in AI as well as the creation of a clear legal and regulatory framework.

Keywords: artificial intelligence (AI), challenges, developing countries, implications, opportunities, tax administration

JEL classifications: H20, H21, H26, O33, K3

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Introduction

Artificial intelligence (AI) is a "buzz" word, topical in advanced technology, digital transformation, economic growth and sustainable development discussions (Mhlanga, 2023). AI is one of the Fourth Industrial Revolution tools that has been widely adopted. Munoko et al. (2020) explain AI as a new technology that mimics and replicates cognitive human judgement and skills. In concurrence, Shakil & Tasnia (2022) describe AI as intelligent systems with the ability to analyse data and build a strong base for decision-making. Albawwat & Al Frijat (2021) observe that AI technologies can reproduce human skills such as hearing, problem-solving and doing logical tests AI has the potential to revolutionise all sectors of the economy, it has modified manufacturing operations, the business environment, financial services, and even social interactions. AI technologies include natural language processing, deep learning, expert systems, big data, data analytics, cloud computing and internet of things among others.

Artificial Intelligence (AI) concerns a group of technologies by which intelligent devices have abilities resembling those of humans such as learning, improving, doing calculations, making decisions and being innovative (Mhlanga, 2023). Advanced technological modifications and developments in hardware and software have accelerated advancements in AI technology, its adoption and implications for businesses, individuals, societies, and economies. AI is likely to catalyse development, economic growth as well as improve the quality of information and statistics thus enabling developing nations to leapfrog over certain conventional obstacles (Susar & Aquaro, 2019; Zafar & Villeneuve, 2018). Despite the possible positives associated with AI, challenges such as AI adoption affects jobs, ethical concerns regarding certain applications and capacity-building requirements as well as implications for the future generation (sustainability, sustainable development and tax education). All these issues need to be evaluated by countries seeking to adopt AI for public administration and e-government.

Tax is a source of funds for both local and central revenue in developing countries (Sebele-Mpofu, 2020). With the reduction in donor funds, development assistance and other international grants, developing countries have been undertaking different initiatives to strengthen their domestic revenue mobilisation

strategies. Harnessing AI in tax administration and the digitalisation of tax administration are some of the measures adopted by developing countries. Tanzania is also one such country (UNDP, 2022). Strengthening domestic revenue mobilisation in developing countries is likely to strengthen sovereignty, reduce aid and donor dependence and increase revenue generation for public finance for the attainment of the sustainable development goals or SDGs (Mpofu, 2021a; 2022a). Therefore, tax system reforms are required in many developing countries to minimise the unfavourable effects of taxation, increase tax compliance, alleviate poverty and fund investment in infrastructure, education and health. Technology is possibly the biggest weapon available that developing countries can exploit in their fight to strengthen their tax administration systems (Walker, 2019). The SDGs are made up of 17 goals that United Nations member countries agreed to work towards achieving in the 2015 Paris Agreement. Most of these SDGs directly touch on tax issues (Walker, 2019) because achieving them requires financial resources and taxation is key in mobilising these resources (Mpofu, 2022b, 2023a)

The use of AI technologies such as deep learning, machine learning, expert learning system, and optical character recognition in addition to other technologies to build tax intelligent systems contributes to the efficiency in dealing with tax-related issues and the effective monitoring of tax-connected risks (Mpofu, 2024). It also assists in reducing human-driven judgement, standardising taxation behaviours and minimising administrative as well as compliance costs. The implementation of AI in the taxation tax administration is associated with governance challenges and other AI-connected risks that might be more pronounced in developing countries due to the political, social, economic, environmental and digital infrastructure contexts in these countries (Zhou, 2019).

Tax evasion is a fundamental matter in developing and emerging economies, where revenue administration is still manually done. Individuals and companies exploit the loopholes and inefficiencies associated with traditional methods of tax administration. Artificial intelligence in tax administration can assist businesses to uphold transparency and compliance with tax regulations, minimising the risks of default, penalties and fines (Shakil & Tasnia, 2022).

According to Serrano Antón (2021), the use of AI by tax administrations can transform tax administration and compliance procedures resulting in the implementation of novel data-oriented tax administrations, automation of repetitive tax administration tasks, heightening efforts toward reducing tax evasion while strengthening communication and information exchange between tax authorities and taxpayers. Moloi & Marwala (2021a) posit that RPA (Robotic

Process Automation) has several benefits, and these include enhanced accuracy, the reduction of costs, e improvements in the governance, better customer advocacy and strengthened customer loyalty. Therefore, the use of RPA in tax administration can improve monitoring by enabling better checks and balances as well as efficiency in integrating existing technologies with new digital technologies. Combining RPA with machine learning and other AI technologies, robotics can also strengthen tax administration and enforcements, especially tax compliance audits (Al-Aroud, 2020; Mpofu, 2023b). Audit procedures to check and verify audit assertions such as authorisation, occurrence and completeness employed by auditors can be automated. This could give auditors time to focus on more complex tasks that demand human cognition. Serrano Antón (2021) emphasises that tax administration authorities need to reflect on data governance concerns and other probable risks linked to the application of AI in taxation, especially how to ensure the responsible, transparent, unbiased and ethical usage of AI in tax administrations, which respects taxpayers' rights while allowing for effective revenue mobilisation. Modern revenue administration authorities need to be effective, efficient and transparent in addressing tax evasion.

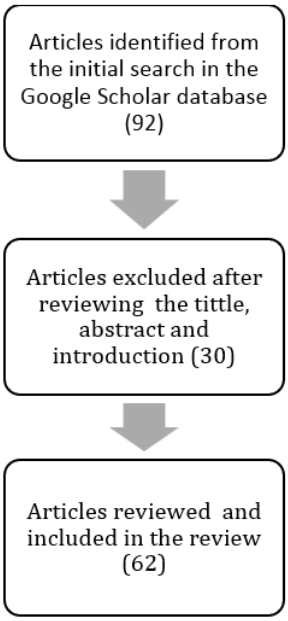
Bassey et al. (2022) contend that developing countries need to explore not just how to build technology acceptance but also explore the creation of a wider digital ecosystem in revenue administration in their countries to improve domestic revenue mobilisation. Additionally, the researchers portend that understanding the contextual environment, stakeholders and their needs, technological requirements and the envisaged outcomes as pivotal components of a digital ecosystem is important for tax administrators in developing countries. Ultimately, Bassey et al. (2022) and Faúndez-Ugalde et al., (2020) highlight the need for research on digital tax administration in developing countries.

Culminating from the brief background given above, through a critical literature review this paper discusses the development and deployment of AI in tax administration in developing countries. The review seeks to explore the state of the art of AI applications in tax administration in developing countries. Through the review of literature, the paper unpacks the possible opportunities, implications and challenges linked to AI in tax administration and contextualises these to the contextual environments in developing countries. The paper consists of five sections. The first section sets the tone of the paper by giving a contextual background on AI in developing countries and the challenges of tax revenue mobilisation in these countries. Section two gives a brief articulation of the review methodology.

Review methodology

A qualitative research methodology was adopted in the form of a critical review. Wakefield (2015) and Mpofu (2021b) posit that researchers can review previous studies, analyse them, collate their findings and identify gaps, inconsistencies and consistencies as well as areas of further research in a critical review. Literature was reviewed until the saturation point was reached. Mpofu (2021c) explains saturation point in interviews as the point where further interviewing does not yield any other new information. In this review, it was the point where no new information arose from further reviewing of related literature. A total of 42 articles were reviewed. The search terms used include "AI in tax administration in developing countries", "Challenges of deploying AI in tax administration in developing countries", "Opportunities from the deployment of AI in tax administration in developing countries" and "Implications of using AI in tax administration in developing countries". The review protocol is given in Figure 1.

Figure 1. Review Protocol Adopted



Source: Author's Compilation

Literature review

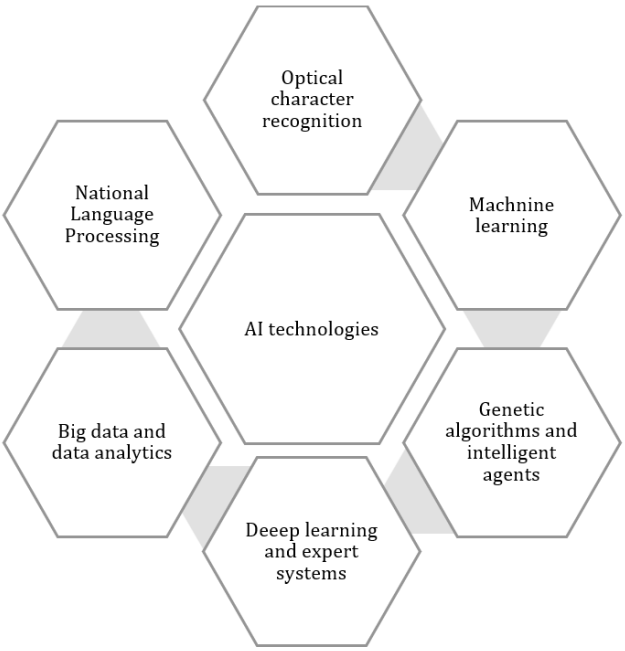
AI has the likelihood of revolutionising tax administration globally and more so in developing countries where tax compliance is low yet effective domestic revenue mobilisation is critical (Mpofu, 2021a). AI can be used to improve the efficiency and effectiveness of tax administration in developing economies (Deloitte, 2019). It can be used to automate tax administration tasks such as taxpayer identification and registration, computation of tax liability, enforcement and management of tax compliance as well as the identification of tax evaders and detection of fraudulent transactions. This could reduce the costs of tax collection and enforcement, prevent and detect tax evasion and unethical tax avoidance as well as enhance tax compliance in developing countries. According to the OECD (2022a), AI could allow for digital transformation in tax administration, enhance service delivery, reduce tax compliance burdens, and increase tax revenue mobilisation if employed in tax administration. This section reviews the literature unpacking the areas of agreement and divergence among researchers on the prospects of AI adoption in tax administration in developing economies.

AI in tax administration in developing countries

AI can be used to address tax administration weaknesses and challenges faced by tax administration in developing countries. For example, when focusing on transfer pricing manipulation in developing countries, Wealth et al. (2023) point to weak tax administration institutions, inadequate capacity, corruption, poor technologies and lack of technical capacity to fully enforce tax legislation as some of the constraints to productive tax administration. Through Robotic Process Automation (RPA), AI Robots can be used as tax auditors in audit risk assessments, identifying misstatements, errors and fraud, categorising transactions and accounts as well as in proposing better tax liability and enforcement strategies (Huang, 2018). Murorunkwere et al. (2022) allude to the likelihood of fraud detection through the use of neural works. There are several possibilities of deploying AI in tax administration that developing countries could explore. Artificial intelligence is quickly transforming tax administration operations globally and developing countries are no exception (Susar & Aquaro, 2019; Zafar & Villeneuve, 2018). In affirmation Serrano Antón (2021) avers that the deployment of AI in tax administration could fundamentally transform tax administration procedures, enhance efficiency and transparency while availing new opportunities to implement data driven tax revenue mobilisation, automate

certain repetitive tax administration processes, strengthen the fight against tax evasion and avoidance and reducing information asymmetry. AI can be used also in tax audits and segmentation of taxpayers (Rahayu, 2021). The researcher further underscores the need to always ensure ethical and responsible implementation and use of AI in tax administration. This entails upholding the rights, privacy and confidentiality of taxpayers and protecting their information (Serrano Antón, 2021). Figure 2 shows some of the AI technologies that can be harnessed for tax administration purposes.

Figure 2. AI technologies



Source: Author's Compilation

Deep learning is a form of machine learning that employs artificial neural works to learn from data. Deep learning technology can be used in the evaluation of contracts such as lease agreements, legal agreements, purchase and disposal contracts as well as mergers and acquisitions (Mpofu, 2023a). These contractual documents have different impacts on tax heads such as corporate tax, value-added tax (VAT), capital gains, and customs duty where assets have been purchased from outside the country. For example, lease agreements could affect

the gross income and allowable deductions depending on whether the taxpayer is the lessor or lessee respectively (Zimbabwe Income Tax Act, Chapter 23: 06 Sections 8 (1) (d) and (e) and 15 (2) d and e). Disposal of a capital asset such as buildings could affect the capital gains tax (Capital Gains Tax Act, Chapter 23: 01). Deep learning could be used to extract and analyse information from the different contracts (Mpofu, 2023b) and objectively show their tax implications. Deep learning can enhance tax administration in the identification of potential tax evasion, automation of tax compliance tasks, provision of personalised service, and foster efficiency and effectiveness in tax administration. Issues of data bias, data availability and explanation of deep learning-driven outcomes and decisions remain problematic. The deployment of AI technology enables the development of audit-oriented novel forecasting and statistical models. AI assists in the prevention and detection of fraud and can also strengthen government control and supervision.

Expert learning systems are a form of AI that can utilised to enhance tax administration. These systems could be trained on a substantial dataset of tax legislation and case law. Additionally, the systems could be used to respond to questions on tax policy based on legislation and case law (Kumar et al., 2023). The expert learning systems could also be used to improve the accuracy of the information, improve communication and response time to queries by the tax authority to stakeholders, provide tax advice to taxpayers, and reduce tax evasion. Commenting on the deployment of an ML/AI-supported tax assessment in India, Kumar et al. (2023) state "Expert systems have been found to offer users a significant amount of control over how they search for solutions, freedom to choose whether to follow system recommendations, and a decrease in the need for supervision". Tax systems seem to allow for more independent work to be conducted, more quick decisions to be made, and a wider range of issues to be addressed. An important source of public funding in a developing country like India is taxes.

Machine learning is a type of AI technology that uses software applications to learn from historical data to make future predictions (Bao et al., 2020). Machine learning uses models and algorithms to conduct data analysis to show trends and patterns and make forecasts. Machine learning uses mathematical formulas and can do classifications and cluster analysis (Dickey et al., 2019). Blanco (2022) posits that AI systems and algorithms must be well-designed and quality data used. This is to ensure adherence to tax principles. Mpofu & Moloi (2022) emphasise the importance of tax administration that adheres to the canons of taxation such as economy, convenience, certainty, simplicity and transparency.

Natural Language Processing deals with the interaction between human language and computers (Moloi & Marwala, 2021b). Natural language processing can be employed in tax administration for the extraction of information from unstructured data such as emails, social media and tax returns, understanding the intentions of taxpayers and automation of certain tax administration functions.

Issa et al. (2016) adduce that AI can be used in the audit function for risk assessments, classifications, application of algorithms, and other audit functions. Equally revenue authority auditors could employ AI in their tax audits in the re-computation of taxable income and tax liability as well as getting insights into the behaviour of taxpayers by assessing the financial and bank transactions. Allami et al. (2022) argue that AI technologies promote objectivity, speed and accuracy in computations and assessment of large volumes of data. While acknowledging these potential opportunities of AI, Landers & Behrend (2022) point out that fairness and bias concerns must always be considered. Instead of sampling transactions due to manual audit techniques, using AI tax auditors could test 100% of transactions.

Despite the potential advantages linked to the use of AI, Aksoy & Gurol (2021) point to the inherent limitations associated with the use of AI. These limitations border around the complexity of AI technology, lack of AI skills, lack of trust and general uncertainties (Fügener et al., 2021). Other researchers raise the issue of biases such as anchoring, availability, confirmation and overconfidence as well as algorithm aversion biases (Commerford et al., 2022; Dickey et al., 2019; Dietvorst & Bharti, 2020).

Focusing on AI in tax administration in Indonesia Saragih et al. (2022) established that applying AI in the discipline of taxation can help revenue authorities in the enforcement of tax legislation, enhance the principle of convenience in the settlement of tax obligations by taxpayers, build justice for taxpayers and minimise tax compliance expenses. The lack of appropriate regulations governing AI applications, as well as the inadequacy of human resources with AI knowledge to gather and process data, and the lack of digital infrastructure are the constraints to implementing AI to modernize tax administration functions in Indonesia.

Kamil (2022) found out that "Artificial Intelligence Technology for Income Tax E-Filling has a significant positive effect on Tax Compliance". While focusing on the use of technologies such as AI in tax administration Granger et al. (2022) point to the importance of the implications concerning the capabilities of tax administrators, tax consultants, taxpayers, and accountants. The researchers further highlight AI adoption discussions should also focus on legal and ethical considerations, capacity challenges, and possible opportunities as well as data

governance matters. On a positive note, Granger et al. (2022) posit that by using AI, revenue authorities could "tap seamlessly into the digital footprints of people and businesses" to mobilise tax revenue.

Opportunities and positive implications of harnessing AI in tax administration in developing countries

Researchers argue that AI is likely to have consequential positive implications on tax administration in developing countries (Pica, 2023; Zhang, 2020). These gains include the possibility of automating the registration for tax process, improving tax compliance, improving domestic revenue mobilisation and an increase in tax revenue. An increase in efficiency, accuracy and transparency in tax administration, reduction in tax administration and compliance costs. AI can enable revenue authorities to address tax compliance challenges such as the understatement and concealing of incomes, understatement of tax liability as well as other fraudulent activities are some of the advantages of using AI in tax administration. AI can also be directed towards the enhancement of enforcement activities. Affirming the advantages of deploying AI in tax administration, Collosa (2020) propounds that in tax administration AI can be used to project revenue collections, risk analysis, detection of fraud patterns, audit purposes and optical facial recognition in customs. All these AI functions could lead to an increase in tax revenue. Some of the anticipated advantages are discussed in the subsections.

a) Taxpayer identification

AI can be utilised to identify unregistered potential taxpayers through the analysis of their personal and financial data. AI can be used to address the challenge of informality to tax administration in developing countries (Twesige et al., 2020). Informality is one of the key challenges to domestic revenue mobilisation (Mpofu, 2021b). AI could be used in the identification of informal businesses for tax purposes, by analysing data from different sources such as land records, financial transactions, mobile money transactions and social media information. This could help revenue administrators to direct their tax compliance efforts more effectively. Furthermore, AI can be employed to assist mobile tax revenue mobilisation which could be convenient and ideal for informal businesses. This could broaden the tax base and increase tax compliance while minimising both the tax administration and compliance costs for revenue authorities and taxpayers respectively (UNDP, 2022). Additionally, AI can be utilised to conduct outreach and educational programs to educate informal

businesses about their tax obligations, how to comply and complete tax returns as well as the benefits of being tax compliant. This could improve tax literacy, enhance taxpayer education and awareness as well as compliance in the informal economy. Concerning enhancing tax compliance in the informal economy the UNDP (2022) adduces "The MSMEs can be identified through big data sources, including national identification number, driving licenses, bank details, utility bills and digital (mobile) transactions. Following that, big data analytics can be conducted to provide details of their whereabouts, value chain and monthly average spending''. MSMEs in the quotation thus referring to Micro Small and Medium Enterprises.

b) Computation of tax liability

Heavily investing in human-oriented administrative matters increases human-to-human interactions in tax administration thus opening crevices for abuse of tax legislation and corruption. This causes a lack of trust in government by taxpayers and impairs the implicit social contract (Mpofu, 2021b). Due to the use of presumptions in the computation of tax liability in most African countries when assessing the tax obligation of small business, trust between taxpayers and tax officials has been eroded. The UNDP (2022) alludes to the loss of trust in tax computations by Tanzanian MSMEs because of the estimation of revenue challenges. The report further states that the manual nature of tax administration is associated with significant cost implications, human capital requirements and assessment delays. Digitalization, AI adoption and the application of big data and data analytics could reduce mistrust, corruption, human interactions and make tax administration more transparent (UNDP, 2022).

The use of AI in tax administration in developing countries could improve accuracy and transparency in the assessment of tax liability. Instead of tax liability assessment being conducted manually, through big data analytics and machine learning taxpayer information is collected easily and quickly. Taxpayer information could also be analysed with a high degree of accuracy. This could improve the accuracy of tax liability assessment, reduce the risk of errors and omissions while enhancing the cogency of tax compliance checks. This could reduce tax disputes.

c) Strengthening tax audits and detection of fraudulent transactions

AI technologies can be used to strengthen tax audits and improve the prevention and detection of fraudulent transactions and income from illegal activities. AI can be applied to trace and detect fraudulent activities following

the digital footprints of incomes and payments. Such transactions could involve money laundering and other schemes used to clean "dirty money" and channel it into the mainstream financial system. This could lead to the combating of tax avoidance and financial crimes thus leading to the recovery of lost tax revenues and the protection of the economy, taxpayers and the public from the negative consequences associated with revenue leakages. Additionally, AI provides simulated tax risks, which can help more complex human judgments to be made. AI can also aid detection of fraud, contributing to its supervision and monitoring by government. The development of AI continues, and its deployment has certain limits and risks that must be recognized (Huang, 2018). The application of AI allows data organisation and tax collections to be more transparent and systematic, thus assisting revenue authorities in developing countries to reduce excessive and unethical tax avoidance, address illegal tax evasion and deal with aggressive transfer pricing and tax base erosion perpetuated by multinational enterprises in developing countries. The persistent problem of aggressive transfer pricing and tax evasion by multinational companies is attributed to weak tax administration systems in developing countries and the opaqueness of transactions done by these companies (Mpofu & Wealth, 2022). Applying AI to streamline tax data by the government increases efficiency and compliance with current policies on tax reporting and reasonable tax avoidance. In addition, to heightening efficiency and solidifying the effectiveness of tax administration, the deployment of AI can help build mathematical tax models, assess tax trends and economic performance indicators, identify and analyse tax challenges faced by corporate and individual taxpayers and review tax policy accordingly. In dealing with transfer pricing, base erosion and profit shifting as well as tax avoidance in developing countries, Mpofu (2022b) advocates for the strengthening of tax administration in developing countries, through the harnessing of technology, training and research. Consequently, by adopting AI tax administrators could diagnose the reasons for non-tax compliance more appropriately, where be it tax evasion or aggressive tax avoidance or poor performance linked to economic challenges (Huang, 2018). This would not only strengthen tax administration but also enable tax compliance constraints to be identified and addressed accordingly to maximise tax revenue generation with suffocating companies with overly burdensome tax rates.

d) Enhancing enforcement and tax compliance

To achieve the following three objectives of effective tax administration, which are (1) a high level of voluntary compliance, (2) a high level of trust in tax administration, and (3) a high level of productivity among tax officers,

Santiso (2022) calls for synergy in digital tax reforms and anticorruption strategies in developing countries. Corruption is one of the fundamental impediments to effective revenue mobilisation and the attainment of SDGs in developing countries. Digital tax reforms could reduce corruption, improve tax compliance and enhance SDG16 on peace, justice and the creation of strong institutions. AI-powered tax administration platforms could help improve tax administration enforcement and compliance (Hassan, 2023; Huang, 2018). For example, by automating some of the repetitive tax such as taxpayer registration and information dissemination. Sending reminders to taxpayers to tax lodge returns, the processing of returns and resolution of tax disputes, time can be freed for other activities. Tasks such as the identification of potential tax evaders, assessing, preventing and detecting fraud as well as other tax compliance-oriented tasks could be delegated to machines. This could lead to a reduction in the workload of tax officers, allowing them to dedicate their attention to other intricate tasks, thus enhancing the efficiency of tax administration systems. By tracking the flow of revenue and easily identifying potential revenue leakages and loopholes, AI-supported tax administration platforms, promote fairness and transparency in tax administration. Thus promoting tax justice which is one of the drivers of tax compliance. AI can also lead to a reduction in costs of tax administration and compliance. Through technologies such as robotic proves automation, by automating repetitive tasks and eliminating areas of redundancy, labour costs could be reduced for both the revenue authority and taxpayers (Hassan, 2023). Automation could also free up resources that could be dedicated to improving other tax administration services.

e) Mitigation of tax avoidance schemes

Tax evasion and aggressive tax avoidance through transfer pricing and other tax planning ways are considered some of the fundamental reasons for the low tax-to-GDP ratio in developing countries (Mpofu, 2022b). By using machine learning technology, AI can be used to analyse large volumes of data that would generally be daunting to effectively analyse and pick trends manually. Through this quick and effective analysis using machine learning algorithms, revenue authorities could detect patterns and suspicious transactions that might point to tax evasion schemes. When dealing with digital technology it is easier to diagnose faults and weaknesses in the tax administration system. AI technologies are impartial, transparent, accurate, user-friendly, and efficient, which might encourage tax compliance and minimise revenue offers' aggressive behaviour towards taxpayers (UNDP, 2022). This might smoothen the antagonistic relationship between taxpayers and tax officers. The use of AI and big data culminate in increased tax revenue and compliance. The deployment of AI is likely to offer linkages and foster the exchange of information between tax

administration functions, tax administration authorities, government agencies and departments as well as the private sector such as mobile money operators and digital payments service providers. Consequently, the use of AI might lead to improved tax compliance and increased tax revenue. Currently, because of the weaknesses associated with manual functions in most tax administration authorities in developing countries tax authorities dedicate most resources toward strengthening enforcement to combat tax evasion and avoidance as opposed to building a conducive environment to promote voluntary tax compliance. Aggressive enforcement leads to low tax morale and increased non-tax compliance in some cases (Sebele-Mpofu, 2020, 2021). AI usage can help prevent tax evasion and unethical tax avoidance. AI and big data offer a solution to the afore-mentioned challenges by instilling systems to detect and counter such practices". While acknowledging the likelihood of enhanced risk management and reduction in tax evasion cases through the use of AI technologies, Binder (2019) argues that the use machine learning algorithms could result in biases or errors in AI-supported risk assessments. The researcher further points to control and complexity as some of the AI associated challenges in risk management practices.

f) Improving communication and decision-making

Ihnatišinová (2021) argues, "Artificial intelligence technology creates new digital communication channels and contributes to more efficient paperless tax administration". The global trend of digital communication involves chatbots, digital assistants and voice bots. This significantly enhances communication, making it easier and faster. This could strengthen tax administration as queries, complaints and questions are attended to timeously. The interaction between taxpayers and tax administrators is made smooth and less of face to face interaction that often lead to intimidation and corruption. Holmes (2017) and Pica (2023) posit that while AI is able to learn from the personal data that it processes through technologies such natural language processing and machine learning it can give deeper insights concerning the data being processed. This could help tax administration authorities attain their goals, set new ones and improve decision-making.

Challenges and negative implications associated with AI in tax administration in developing countries

Even though the use of AI in tax administration in developing countries heralds a lot of opportunities and positive implications, several challenges need to be addressed. To ensure AI is effectively harnessed to improve tax administration, enforcement and compliance as well as ultimately broaden

domestic revenue mobilisation in developing countries, governments and their revenue authorities need to deal with the possible constraints and negative externalities. These potential constraints include the digital divide, illiteracy challenges, lack of technical expertise, limited financial resources, data availability challenges, informality and legislative as well as regulatory challenges and ethical implications. Summarising the risks of AI implementation, Collosa (2020) groups them into intrinsic risks (related to the data), and extrinsic risks (associated with AI adoption in society). Intrinsic risks have to be considered to ensure fairness and inclusiveness, privacy and security of data, transparency and accountability as well as security and reliability. These have to be incorporated at all stages of AI development and deployment. Extrinsic implications focus on what AI holds for the future. For example, the OECD (2019a) emphasises that AI adoption should result in sustainable development, and inclusive growth and promote the social well-being of people. Therefore, understanding the challenges that could hinder the fruition of these expectations is crucial in addition to the possible positive and negative consequences.

a) The digital divide and lack of technical expertise

Tax consultants and accounts generally used advanced technologies and automated programs in their tax advisory work (Pavlova & Knyazeva, 2021). While these tax professionals might find their communication and engagements with tax administration authorities improved, for ordinary taxpayers such as sole traders, small scale miners, informal traders and small and medium enterprises might lack the special digital competencies to interact with AI-based tax administration systems. The platforms powered by AI can be complicated to use. Due to the complexity of these platforms and the general digital divide in most developing countries, taxpayers may face challenges in using these platforms. This might lead to a digital divide in non-tax compliance or tax avoidance, thus reducing tax revenue mobilisation. Mhlanga & Ndhlovu (2023) points out that while emerging economies are embracing the 4IR technologies they are doing so at a slow pace as compared to developed countries. Therefore, in some developing countries, there might be a digital or technical expertise gap, and there might be a shortage of expertise to implement and operate AI-supported tax administration platforms. According to Mpofu (2023a) generally, most developing countries have technical expertise or skills gaps and more so in the public sector. Consequent to poor remuneration in the public sector, revenue authorities in developing countries struggle to attract and retain those with the relevant and requisite skills to implement AI in tax administration.

b) Limited financial resources

The adoption of new technology is often connected to significant capital requirements. Companies need to have large amounts of money to invest in digital equipment and software. Therefore, AI-powered platforms might be expensive to develop and launch. Many developing countries often suffer from limited financial resources due to weak revenue domestic mobilisation, porous tax administration systems, tax avoidance and corruption among other factors (Wealth et al., 2023). The budget for tax administration authorities might be limited and inadequate to fund substantial expenditures and other costs associated with the development and deployment of AI-supported platforms. The limited resources might also make it difficult to invest in AI or technology-oriented human capital development and training.

c) Legal and regulatory challenges

While the adoption of AI has received significant attention and the developments in AI are moving with great speed, the formulation regulatory frameworks to govern the use of AI is slow paced especially in developing countries (Mpofu, 2023a). Some developing countries might experience legislative and regulatory challenges relating to the utilisation of AI technologies in tax administration. These regulatory problems have implications for tax audits and tax dispute resolutions. These challenges need to be considered to ensure the effective, ethical and responsible application of AI in tax administration.

d) Informality

The informal economy is one of the fundamental challenges of revenue authorities in developing countries. The informal economy contributes very little to developing economies yet the sector contributes substantially to the Gross Domestic Product (GDP) of these economies (Sebele-Mpofu, 2020; Mpofu, 2021a). It is challenging to mobilise tax revenue from the informal economy because the economy is a cash economy characterised by unregistered businesses, mobile businesses, lack of information and transparency (Rogan, 2019). Considering AI systems are dependent on the availability of data and the quality of data used for training the AI-powered system, it might be challenging to get the data from the informal economy.

AI technology could be applied to the tax administration of Micro Small and Medium Enterprises (MSMEs). The technologies can be used to track the mobility of MSMEs, improve the record keeping of their transactions especially those using mobile money services, link them to buyers and sellers, and trace their transactions (UNDP, 2022). Furthermore, by using AI to identify MSMEs,

they can be assisted to formalise, mage and grow their businesses better as well as enable them to access government services and financial services. This could improve tax administration, tax compliance and tax revenue generation from the informal sector. As posited by the UNDP (2022):

"The investment that goes into tax collection and administration systems, instead of automating the systems, specifically results in enforcing compliance without necessarily increasing tax collections. For instance, most of the countries are injecting their resources into activities such as tax audits, tax evasion and fraud detection as well as adding pressure on noncompliant taxpayers to increase tax revenue though in reality, they raise the administration costs without any significant additions to the collections".

Therefore, whether AI-supported tax administration would help in increasing tax compliance in the informal sector or just increase costs in investing in technologies depends on several factors. For example, the use of digital financial services such as mobile money in the African countries could improve tax collections from the informal sector.

e) Resistance to change

Considering that technology may be both transformative and disruptive, there may be resistance to change to AI-supported tax administration by employees and taxpayers. Millan Vargas & Sandoval-Almazán (2024) and Mpofu (2024) allude to the resistance to change as big challenge in the implantation of digital technologies in public administration.Tax officials who are comfortable with the conventional methods of tax administration may not be open to modern ways of tax administration. Therefore, they can resist change and may be unwilling to embrace AI.

f) Lack of political will and corruption

In some developing countries, there may be no political will to invest in AI-supported tax administration systems. This could be linked to the abuse of tax systems by the politically connected in most African countries. AI systems might limit changes of circumventing tax regulations and corruption. The government may also not give the necessary commitment and support to tax administration authorities in the form of financial and technical resources needed for the development and deployment of AI-powered tax administration. This might cripple the adoption of AI. In some cases, even where adequate or substantial financial resources have been dedicated to AI projects, corruption could impede the implementation of AI in tax administration. In most African

countries, corruption is a big issue in government projects where funds are embezzled, there is poor workmanship, or projects are left uncompleted when funds have been misused or diverted and costs are overstated.

g) Data availability constraints

AI-supported platforms and activities generally depend on large volumes of data to train and operate some machines. While this data could be collected using AI technologies such as big data and data analytics, in some developing countries data availability may be a big constraint, especially in African countries where the degrees of informality are very high. The informal sector is observed to be characterised by low levels of tax compliance, poor record keeping, and at times low levels of digital, tax and financial literacy. The sector is viewed as a cash economy (Mpofu, 2021c; Sebele-Mpofu & Moyo, 2021).

h) Changing tax policy

Tax policy is generally evolving, constantly being updated and revised, and accordingly, this will require that AI applications employed in tax administration are updated and amended to respond to new tax legislation and new risks emerging from the dynamism of the business environment (Huang, 2018). Consequently, AI systems would have to be improved to produce accurate outcomes. Ensuring that the AI systems remain abreast with the changes in tax policy requires financial resources and technical expertise, which are lacking in developing countries. Additionally, considering AI adoption is still in its infancy in developing countries, and the AI system will have to be updated manually, this might affect the effectiveness of the system.

Case studies on the use of AI in Tax Administration in Developed and Developing Countries

This section gives an insight brief into some of the developed countries that have employed AI in tax administration. The section also provides a summary of case studies of developing countries that have adopted AI in tax administration in developing countries. The case studies give an insight into the motivations for harnessing AI in tax administration as well as to accentuate the possible benefits, challenges, and implications of applying AI technologies in tax administration developing countries.

Sweden harnessed AI in taxpayer registration from May 2021. Categorisation of taxpayers is done digitally thus saving time. The registration process has shortened the registration time and reduced the costs of registration by an estimated 16% of the total costs of the process. France also uses machine learning algorithms to detect hidden or undeclared developments and constructions, as well as to check whether taxpayers pay the correct tax, specifically real estate taxes. Countries such as Canada, Australia, Finland, the United Kingdom and Ireland among others use virtual assistants and chatbots to provide personalised services to taxpayers. In Canada, CRA is making use of machine learning, natural language processing, and data visualisation packages to digitally transform the accessing, processing, and data analysis. The revenue authority has also offered training to empower the accounting profession to harness AI and data analytics. The tax authority of Singapore uses AI across all tax administration functions to improve tax compliance and service provisioning to taxpayers (through service quality monitoring using live chats and natural language processing models). AI has increased productivity and objectivity in tax administration by using feedback from live chats to enhance the tax system (Collosa, 2022). CRA could quickly responded to the COVID-19 pandemic, by exploiting their digital readiness to continue interacting and offering services to taxpayers and the government (OECD, 2022a). While AI technologies are greatly used in developed countries in taxation, Owens & Schlenther (2022) submit that several countries in Africa are adopting digital technologies in their tax systems to boost domestic revenue mobilisation.

Van Rooi (2023) gives examples of Rwanda, South Africa and India as some of the countries that have harnessed the 4IR technologies in their tax administration systems. While focusing on the levels of adoption and usage of the 4IR technologies in some countries in both the developed and developing contexts, Adams (2022) ranked these countries based on certain performance measures according to the achievement criteria (achieved, partially achieved and not achieved). In terms of gaining awareness, fostering positive attitudes and perceptions towards 4IR technologies adoption, India, Rwanda and South Africa were ranked to have achieved this. On the use and effectiveness of using 4IR tools in taxation, Rwanda was ranked as having achieved, while India and South Africa as having partially achieved this goal (Adams, 2022; Van Rooi, 2023). Julius & Christabel (2020) adduce that the East African community uses the Regional Electronic Cargo Tracking System (RECTS) to monitor the cargo that is transported from Kenya through to countries such as Uganda, Rwanda and the democratic Republic of Congo.

This study looked at South Africa, India, Kenya, Indonesia, Rwanda, Nigeria and Mexico as some of the developing countries that have applied AI

technologies in their tax administration functions. While the countries share some commonalities in terms of opportunities, challenges and implications associated with AI-driven tax administration, differences also exist in these three areas due to the variations in the level of development as well as economic, political, social and legal differences in the contextual environments.

South Africa

According to the South African Institute of Public Accountants (SAIPA) (2021) and South African Revenue Services (SARS) (2021) adduce that SARs was integrating the 4IR technologies into the tax system. While South Africa Revenue Services (SARS) launched an AI-driven tax administration platform to improve tax compliance in the country. The platform utilises machine learning to analyse data collected from taxpayers' records and pinpoint potential disparities or suspicious trends (Moodley, 2024). Quoting the SARS commissioner, the author observed that while using AI, data analytics and other proactive risk management measures SARS was able to recover approximately R210 billion through their activities targeting illicit economic activities and tax evasion. This is pivotal in enforcing tax compliance as well as enhancing efficiency in tax administration. Assessing the impact of employing the 4IR technologies in tax administration in South Africa Van Rooi (2023) identified both favourable and unfavourable outcomes. On the positive side, concerning tax heads such as VAT, personal income tax and corporate tax, the researcher points out that tax system automation improved, e-filling of tax returns, communication with taxpayers, efficiency and tax compliance. On the negative, the researcher further submits that the adoption of the 4IR technologies amplified the associated need for upskilling and reskilling and made evident the possibilities of job losses in the near future.

Kenya

The Kenya Revenue Authority (KRA) introduced an AI-supported platform known as iTax that was employed for the identification of potential tax evaders, thereby improving tax compliance and mitigating tax evasion (Oeta, 2017). Using machine learning iTax analyses data from taxpayers' bank accounts and transactions. This enables the revenue authority to understand the income and expenditure patterns of taxpayers and identify the taxpayers who evade tax or understate their tax liability. Owens & Schlenther (2022) portend that AI can be used for risk management, deploy data analytics to drive targeted, tax compliance, profile taxpayers and enhance tax compliance product and resource optimisation. Akinrinola et al. (2024) adduces that while there is

progress in automation of tax administration processes, gaps are still evident in statistical analysis and large volumes of data, data quality and tax compliance. Therefore, it is imperative to understand the progress, opportunities and the likely barriers of applying the 4IR technologies in tax administration in Africa

Indonesia

Indonesia is one of the countries that have made progress towards harnessing Artificial Intelligence (AI) to strengthen tax administration functions (Nugraha, 2023; Saragih et al., 2023). The AI-supported platform known as DJP-AI is used for the identification of fraudulent activities. The AI-backed platform utilises machine learning in the analysis of taxpayers' data extracted from tax returns and other transactions of the taxpayer. This enhances tax administration, reduces tax evasion and increases tax compliance. Nugraha (2023) states that some of the positive outcomes that emanated from infusing AI into tax administration relate to better compliance analysis and targeted taxpayer support as well as monitoring. Lastly, the limited AI adoption and usage was linked to lack of awareness and regulations gaps, pointing to an exigent need for continuous endeavours to enhance AI-based tax administration (Nugraha, 2023). When studying AI-based tax administration in Indonesia, Saragih et al. (2023) found that AI improved tax administration enforcement, convenience in filing tax returns and tax justice and lowered the tax compliance costs. Consequently, this boosted domestic revenue mobilisation. The progress of the Indonesia in integrating AI in tax administration system modernisation is attributed to the commitment to support technological developments by national government as shown by the AI National strategy. Challenges to effective deployment of AI in tax administration in Indonesia were identified to include the lack of clear regulations for the governance of AI adoption, lack of AI skilled personnel, attitudes towards digital transformation, unavailability of data to support AI models as well as the lack of adequate and modern digital infrastructure (Saragih et al., 2023). Therefore, to address the above challenges it is imperative improve the quality of data, provide support for integrating AI in taxation through training and awareness programs for tax officials and taxpayers as well as the improvement of data quality.

India

Rathi et al. (2021) observe that the Indian government announced its intention integrate AI and machine learnin in tax administration activities. Saragih et al. (2023) adduce that India and Malaysia have adopted AI-driven platforms in managing tax compliance. The Indian tax system uses machine

learning for analysing data from the records of taxpayers. Chatbots are also used to communicate with taxpayers and other stakeholders while RPA has been applied to digitally carry out some repetitive tasks. In concurrence, Shakil & Tasnia (2022) portend that India is using AI in the administration of the goods and services tax as well as in carrying out e-audits. This helps foster tax compliance. While studying the influence of factors such as tax system complexity, tax education and knowledge, perceived fairness, taxpayer attitudes and perceptions on the adoption of AI in tax administration, Rathi et al. (2021) observe that while the tax authority has made progress in applying AI technologies in tax input data, data processing and decision making, there was a gap in taxpayer education and awareness towards AI. The researchers recommended comprehensive AI and tax education and awareness programs to build trust and acceptance of AI as a tool to ensure tax justice, accountability and transparency in taxation.

Nigeria

In Nigeria, the Federal Inland Revenue Services (FIRS) is working on an AI-powered digital platform. This platform could be employed to detect fraudulent transactions. The platform is expected to use machine learning to analyse data from the tax returns submitted by taxpayers and other transactions done by taxpayers. Kifordu (2021) is of the view that the adoption of machine learning in Nigeria could help minimise tax fraud and corruption. The researcher further avers that while machine learning presents great opportunities for tax revenue forecasting such as enhanced accuracy, challenges such ethical considerations. Model interpretability and data complexity threaten the potential to reap the envisaged benefits. The objective is to assist the FIRS minimise tax evasion, recovering any revenue lost through tax evasion, and protecting taxpayers from financial losses.

Mexico

Mexico is another country applying AI in tax administration using machine learning for the analysis of taxpayers' bank accounts and transactions. This gives authorities some insights into the income that accrues to the taxpayer. Tax officials can assess whether the taxpayer pays the correct tax liability. This minimises instances of tax avoidance (Zumaya et al., 2021; Junquera-Varela et al., 2022). Artificial neural works and machine learning are used for forecasting fraud detection, risk assessment and in the identification of patterns by tax evaders. Therefore, these technologies could also be useful in identifying money laundering, corruption, bribery and other financial crimes or

illicit financial flows. These ills negatively impact domestic revenue mobilisation in developing countries and sustainable development efforts. Wealth et al. (2023) points to the loss of revenue due to aggressive transfer pricing in Africa and Zimbabwe in particular. Zumaya et al. (2021) call for caution to be applied in the use of these technologies as they have both strengths and limitations. Strengths include the ability to use sophisticated statistical methods, processing large data sets and the increased speed and accuracy at which certain tasks could completed. Overconfidence in the potential impact of these technologies in transforming several facets of businesses and daily lives has led to their limitations not being properly and comprehensively defined. Challenges include lack of skills, limited comprehension of AI technologies. This suggests the need to develop competencies. Consequently, research that situates the opportunities and risks of these technologies developed and developing contexts is critical

Rwanda

The Rwanda Revenue Authority (RRA) adopted an AI-driven system that is employed improve tax, registration, filling of tax returns and declarations, for settling tax liability obligations and to identify potential tax evasion and fraud using natural language processing. Describing the use of AI technologies in taxation in Rwanda, Twesige et al. (2020) refers to it as smart taxation. When assessing how smart taxation affected tax compliance in Rwanda, the researchers established that there was a strong and positive association between smart taxation and tax compliance. Twesige et al. (2020) further suggest that training for both taxpayers and RRA employees on digital skills to enable them to effectively embrace the new technological advancements and developments emerging in the 4IR.

Julius & Christabel (2020) portend that that the East African community uses the Regional Electronic Cargo Tracking System (RECTS) to monitor cargo that is in transit from Kenya through countries such as Uganda, Rwanda and the Democratic Republic of Congo. AI has the potential to revolutionise customs operations and increase revenue mobilisation through customs duties. The researchers further conclude that Public Private Partnerships (PPPs), having a clear change management strategy and combining RECTS with other customs systems, together with the development of digital skills for tax offers would strengthen digital transformation in the East African countries. Julius & Christabel (2020) further submit that machine learning, data mining and AI could contribute significantly to reducing tax fraud. The researchers found out that AI neural works were able to identify tax fraud with an accuracy of 92%, a

precision of 85% and a recall score of 99% in Rwanda. Therefore, these arguments point to great possibilities for minimising tax avoidance and evasion in developing countries through the deployment of AI in tax administration.

In a nut shell, above case studies are just some of the selected examples of developing countries that have adopted AI or are working toward harnessing AI in tax administration. With technological advancements, digital transformation, the evolving business world, the expanding digital economy, the evolution of money and the birth of digital currencies such as bitcoin and central bank digital currencies (CBDCs).

Implications of Using AI in Tax Administration in Developing Countries

The OECD (2019a) suggests five principles that must govern the implementation. These are prudence, no-discrimination, proportionality, transparency and data governance principles. The principle of prudence focuses on the complexity of AI technologies as such the principle advocates for pilot tests or smaller-scale adoption of AI before wide-scale adoption. Cost-benefit analysis is also critical considering AI adoption requires significant financial investment. The principle of non-discrimination calls for careful consideration of algorithm biases and human errors that might lead to discrimination or unfair treatment. The principle of proportionality concerns the rights and guarantees of taxpayers versus the AI applications and decisions derived from AI technology outcomes. The principle of transparency concerns allowing taxpayers access to information for example about why a certain decision is made, be it reassessment of tax liability or levying penalties. In this case, the question is, are revenue authorities willing to give taxpayers access to the algorithms and information used and the processing parameters among other things? Lastly, the data governance principle relates to the security of data, how confidentiality and how the privacy of taxpayers is protected and respected (OECD, 2019a). How data privacy and confidentiality is protected and ensured respectively can affect technology acceptance by users and taxpayers in this case. This consequently points to several implications for taxpayers.

a) Ethical implications

Additional to the challenges associated with AI in tax administration, it is also pivotal to highlight the possible ethical implications connected with the adoption of these technologies. When applying AI in tax administration it is

important to note that large volumes of data concerning taxpayers would be collected. How this data is collected, stored and used is very essential as some of the data concerns personal information, activities and incomes of taxpayers. If the data is not ethically and responsibly used or securely stored and protected it can be wrongfully accessed and used to the taxpayers' detriment (Collosa, 2020, 2022). Developing countries are often characterised by weak privacy and regulations, this raises questions about the ability of revenue authorities to protect the privacy of taxpayers and adequately uphold the principles associated with data collection, storage, and protection. Therefore, revenue authorities need to protect taxpayers' information against abuse, data theft and ensure that the data is not utilised in a way that violates the privacy of taxpayers or discriminates against them. There is also a likelihood of certain job being made redundant as a consequence of harnessing AI in tax administration. As machine learning and AI continue to advance in the future, they will significantly alter the job market in ways that were never envisaged, replacing jobs that are predictable and repeatable with machine supported ones (Agarwal, 2018). Some jobs might be lost, new jobs might emerge and some jobs might need upskilling and re-skilling to be done to augment the interaction between AI and humans in some areas. All this has social, economic, technological, political and legal considerations for developing countries.

b) Risk management implications

By using AI and machine learning in tax administration, tax administrators can be able to manage large data sets and increase the power of technology, opening new avenues for risk management in tax administration. Tax administrators can identify concealed assets, identify new areas of risk and easily identify risks that were previously difficult to define (Collosa, 2022; OECD, 2022b). Notwithstanding the positive implications, negative implications such as the increased risk of cyberattacks, system failure and digital exclusion leading to non-compliance and lack of trust must be considered.

Discussion of findings

The review highlighted the importance of AI in tax administration in developing countries. The findings can be summarised in three important areas. These are the importance of creating a conducive environment for the deployment of AI in tax administration in developing countries, the opportunities and changes of AI-supported tax administration in developing countries, and possible implications for adopting AI in tax administration in developing countries.

Importance of a creating conducive environment for deploying AI

The review established that there is a growing call for AI-powered tax administration in developing countries, yet this overlooks the importance of building an enabling environment for launching AI-driven tax administration. To productively harness AI in tax administration having a conducive environment is irrefutably pivotal. Revenue authorities only successfully deploy AI, engage in digitalisation, or adopt ICT if they have a clear vision and strategy as well as planning as opposed to opportunistic or reactive adoption. The AI adoption plan must have a futuristic digital tax administration adoption roadmap, which takes into consideration available resources and technology, tax legislation, laws and regulations governing technology use, data availability and digital infrastructure among other things. Affirming this observation, the UNDP (2022) recommends:

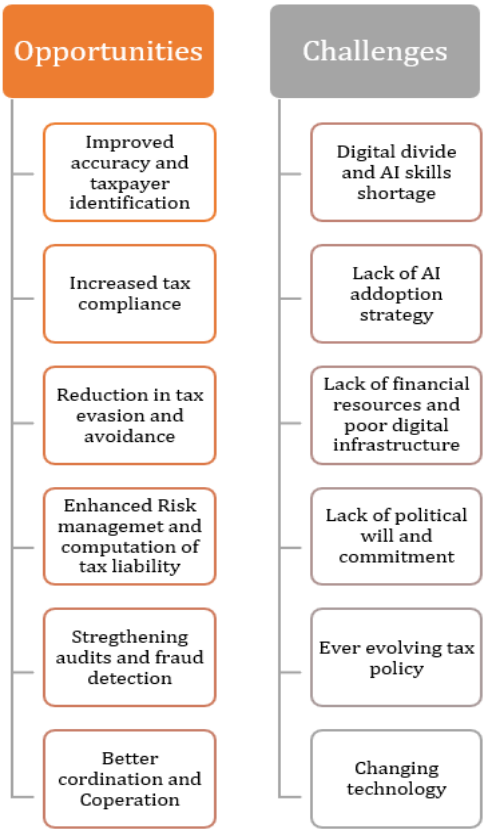
"When developing a roadmap and prior to digitalization, tax, and customs administrations need to declutter the administrative rules, eliminating unnecessary reporting requirements and ensuring that those that are kept would fit into the digital age. It is important to establish strong leadership commitment at the executive level and create governance structures that remove blockages and allow for collaboration, while holding project managers accountable. Ensuring the quality of the data collected and that it is fit-for-purpose and relevant is a key aspect toward effectively digitalizing tax and customs administrations".

Therefore, the next subsections discuss the review findings in relation to opportunities and challenges of AI-driven tax administration as well as the implications and recommendations for improving AI-supported tax administration in developing countries.

Opportunities and challenges of AI-supported tax administration in developing countries

The review identified several opportunities and Challenges connected to adopting AI in tax administration in developing countries some of these are summarised in Figure 3. AI can be used to ameliorate tax administration challenges as well as to model taxpayer behaviour so as to design measures to combat tax fraud or set up contingent plans to address different ways that taxpayers in which taxpayers can respond to AI deployment.

Figure 3. Opportunities and Challenges for AI-driven tax administration in developing countries



Source: Author's Compilation

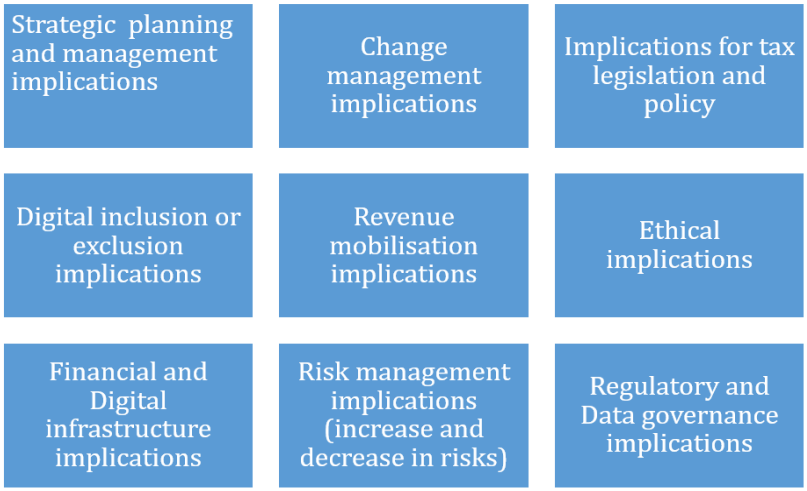
Implications for AI-supported tax administration in developing countries

In this time of the growing digital economy and digital transformation in almost every sector of the economy, to remain relevant and effective in their roles revenue administration authorities must augment their tax administration functions (e- administration for both customs and tax administration) by harnessing information, communication and technology (ICT). The review found that there were various implications both negative and positive linked to the deployment of AI in tax administration requirements. These are also associated with the opportunities and challenges above. The OECD (2019b) in

particular affirmed the importance of understanding the implications for adopting AI technologies in general and tax administration, observing that AI implications need to be assessed from various dimensions such as the ethical, sociological, technological, economic, legal and political dimensions. These implications range from the planning stage, and risk assessment to the implementation, monitoring and post-implementation audit stages. Masseno (2020) posits that one of the pressing ethical challenges associated with using AI in tax administration concerns the probability of remodelling anonymised in the hands of tax administration authorities to reconstruct the personal data of taxpayers, enabling identification of the taxpayer. Cockfield (2010) affirms this concern arguing that taxpayer information in the hands of revenue administration authorities generally encompass sensitive personal information such as income details (amount of income and sources of income), employment status, donations, spending, investment and savings, personal assets, mortgages, child maintenance and alimony, professional and personal club membership fees as well as personal circumstances such as disability and age. This comprehensive personal data may be exploited to reconstruct an in-depth profile of a taxpayers' identity, revealing issues such as religion, political affiliation and other financial behaviour aspects (Cockfield, 2010, 2016).

These implications are summarised in Figure 4. Developing countries need to understand and address these implications to improve the deployment of AI in tax administration.

Figure 4. Implications for AI Adoption in Tax Administration in Developing Countries



Source: Author's Compilation

A comprehensive understanding of these implications is likely to contribute to the development and deployment of AI in an ethically way and to ensure that AI in tax administration addresses the practical, economic and social implications in line with the needs of the various stakeholders.

Conclusions, limitations, recommendations, and areas of further research

AI is anticipated to be a powerful technology in the digital transformation of tax administration in developing countries. It could be harnessed to improve tax compliance and strengthen domestic revenue mobilisation in developing economies. Additionally, through AI deployment revenue authorities could make tax administration and enforcement more systematic, effective, accurate and transparent. This might also assist in reducing aggressive tax avoidance by multinational enterprises as well as tax evasion through exploitative transfer pricing abuses that lead to base erosion and profit shifting in developing countries. Furthermore, data gathered through AI technologies such a big data can be can be used to design mathematical models through machine learning, assess the tax collection trends, make future projections and help make informed decisions for the review of different tax policies. AI enhances the systematic processing and transparency of tax data, which increases the intensity of government supervision and motivates the ongoing modernisation of tax administration function. Transparency in tax administration can help build trust in tax systems, thus boosting morale and resultantly increasing tax compliance. Consequently, it is crucial to assess carefully the challenges, opportunities and possible implications that can emerge from the application of AI in tax administration. It is worth noting that the impact of the opportunities and challenges as well as how these are exploited and mitigated will depend on the contextual, legal and regulatory environments of each country as well as their tax policy and other factors such as how technology is embraced, digital literacy and government support.

Recommendations

From the literature review, it was deduced that developing countries might need to improve in some areas to create a conducive environment for the development and deployment of AI in tax administration. Informed by the challenges discussed in prior sections, this section makes possible suggestions to mitigate the challenges and harvest the gains of using AI to enhance the

efficiency and effectiveness of revenue administration in developing countries. These recommendations include having a strong team with strong leadership to lead the adoption of AI in revenue authorities, dedicating financial resources towards the development and deployment of AI systems, minimising corruption in the launching of the AI project and building relevant technical expertise for the use of AI in tax administration.

a) Implementation of AI in phases

Given the challenges facing revenue authorities in developing countries regarding the adoption of AI in tax administration such as the shortage of financial resources, limited technical expertise, and poor digital infrastructure, a phased approach could be adopted. Revenue authorities could use a staggered approach to implementation by breaking the project into small manageable phases that accommodate their limited budgets. The tax administration authorities could start with minor pilot projects and intensify the adoption as and when funds become available. This not only helps plan for the investment in AI for tax administration but also ensures that the project is done gradually to enable time for change management for both revenue authorities and taxpayers.

b) Create a pool of data for taxpayers' database

Requirements needed due to the use of new technologies by the tax authorities highlighted earlier AI technologies such as big data, data analytics, and machine learning require large amounts of data and in this case taxpayers' data, it is critical to create a reliable and strong database. This entails collecting, categorising, and securely storing large volumes of data concerning businesses, taxpayers, and transactions. This data can then be used for the training and deployment of AI-driven systems.

c) Invest in AI education, skills development, and training

Governments, revenue authorities and educational institutions in developing countries need to invest in AI education and technology in education in general. This is pivotal for the creation of a digital and AI-skilled workforce, starting from university and college graduates. Some revenue authorities such as Zimbabwe have their training schools where they train the graduates that they would have recruited for employment specifically in tax administration. Courses on digital tools and technologies such as the 4IR technologies, the Fifth Industrial Technologies, Fintech, and Forensic audit technologies could be incorporated to equip these prospective tax officials with appropriate digital knowledge. Revenue authorities could also upskill the current workforce through training, seminars,

and continuous professional development programs. This could make employees more comfortable, knowledgeable, and effective in the use of technology and in this case specifically AI technologies. Lastly, revenue authorities could invest in technical expertise, that is by ensuring their pay market-related remuneration and benefits that can attract and retain employees with the right skills to develop and deploy AI-supported systems. This also requires support from the government and ministries of finance to fund the investment in AI education, skills development and training as well as attractive salaries. Governments should also invest in research and development in AI as well as in digital infrastructure and technologies that aid in the building of ecosystems that allow for knowledge sharing and data sharing among government departments.

d) Collaboration with the private sector

Revenue authorities in developing countries could collaborate with the private sector in the development and deployment of AI-supported systems. Tapping from the private sector skills and experience, through collaboration and outsourcing technical expertise, revenue authorities could successfully develop AI-driven solutions for tax administration.

e) Construct strong laws and regulations on data privacy and security

AI systems collect and analyze large volumes of personal data. This raises privacy and confidentiality concerns. With AI systems being relatively new in developing countries, countries need to construct appropriate and effective privacy laws and regulations to protect the privacy of taxpayers. Developing countries should formulate legal and regulatory policies that enable the implementation of secure and dependable AI systems that foster collaboration and cooperation with revenue authorities in other countries. Countries should also put measures in place to reduce harmful and unanticipated outcomes that can perpetuate inequalities and tax injustice intentionally or unintentionally. AI tax administration must not violate the rights of taxpayers and harm disadvantaged populations. Having the appropriate legal and regulatory frameworks toward data privacy and security will also boost public trust and confidence among taxpayers about the use of AI in tax administration.

f) Communication with employees, taxpayers, and other stakeholders

Change is generally associated with some resistance and mistrust from both employees and stakeholders and in this case taxpayers. AI adoption is relatively novel in many developing countries and there is some mistrust associated with the introduction of new technologies more so in tax administration. To

ensure smooth and acceptable change management, revenue authorities must have strong leadership for the AI deployment project. This leadership will not only spearhead the development of the AI system but mobilise financial and technical resources to support it, communicate, and share the AI-powered system vision and strategy of deployment. Successful change management requires acceptance and support by employees. Tax administration authorities must also develop a culture of innovation among their employees. This would enable them to accept and embrace change as well as to feel free to share new ideas and even give criticism and constructive feedback that could improve the AI system. Tax administrators are often considered very aggressive towards taxpayers, hence the relationship is volatile, AI development and deployment would be seen to be another way to exploit or overtax taxpayers. Therefore, tax administration authorities need to build trust by ensuring transparency and accountability in the use of AI. Trust could also be fostered by communicating with taxpayers about the use of AI in tax administration, addressing the what, how, and why questions. Revenue authorities need to be transparent in their communications by sharing the benefits and potential limitations as well as how taxpayers could mitigate the potential negative externalities.

g) Government commitment or political will

There is a need for government commitment and political will to support the development and deployment of AI technologies in tax administration. According to the OECD (2022a) government officials and institutions such as the Ministries of Finance need to be aware of the potential benefits of AI in tax administration and be convinced and willing to invest in these systems. The costs might be substantial in the short term but the envisaged benefits might compensate for the investment in the long term. The costs of IFFs, smuggling and tax evasion are significant in developing countries. Substantial potential revenues are lost, yet these could fund infrastructural development, poverty alleviation and the attainment of the SDGs in developing economies.

Limitations and areas of further research

This paper is a review paper and considering that the use of AI technologies in developing countries is still in its early stages, research in AI-supported tax administration is still minimal but growing, therefore the review only found a few papers relevant. To address this void, the journal articles found were also supported with grey literature. Conference papers, African Tax Administration Forum, OECD and UNDP working papers and policy briefs were also used. The

limitations of grey literature could have affected some of the arguments raised in the review. Future researchers are encouraged to do empirical research on the few developing countries that have deployed AI in their tax administration systems to assess the benefits, constraints and likely implications pointed out in this review.

REFERENCES

Adams, S (2022). 4IR and Tax. A Comparative Study of South Africa and Selected Countries. Available at: https://ujcontent.uj.ac.za/esploro/outputs/journalArticle/4IR-and%20Tax%20Comparitive/9916209307691?institution=27UOJ_INST

Agarwal, P.K. (2018). Public administration challenges in the world of AI and bots. *Public Administration Review*, 78(6), 917-921. https://doi.org/10.1111/puar.12979

Akinrinola, O., Addy, W.A., Ajayi-Nifise, A.O., Odeyemi, O. & Falaiye, T. (2024). Application of machine learning in tax p*rediction: A review with practica*l approaches. *Global Journal of Engineering and Technology Advances*, 18(02), 102-117. https://doi.org/10.30574/gjeta.2024.18.2.0028

Aksoy, T. & Gurol, B. (2021). Artificial intelligence in computer-aided auditing techniques and technologies (CAATTs) and an application proposal for auditors. In: Aksoy, T., Hacioglu, U. (eds), *Auditing Ecosystem and Strategic Accounting in the Digital Era. Contributions to Finance and Accounting*. Springer, Cham., 361-384, https://doi.org/10.1007/978-3-030-72628-7_17

Al-Aroud, S.F. (2020). The Impact of artificial intelligence technologies on audit evidence. *Academy of Accounting and Financial Studies Journal*, 24(2), 1-11. Available at: https://www.abacademies.org/articles/the-impact-of-artificial-intelligence-technologies-on-audit-evidence-9869.html

Albawwat, I. & Frijat, Y. (2021). An analysis of auditors' perceptions towards artificial intelligence and its contribution to audit quality. *Accounting*, 7(4), 755-762. https://doi.org/10.5267/j.ac.2021.2.009

Allami, F.A.J., Nabhan, S.H. & Jabbar, A.K. (2022). A comparative study of measuring the accuracy of using artificial intelligence methods as an alternative to traditional methods of auditing. *World Economics and Finance Bulletin*, 9, 90-99. Available at: https://scholarexpress.net/index.php/wefb/article/view/784

Bao, Y., Ke, B., Li, B., Yu, Y.J. & Zhang, J. (2020). Detecting accounting fraud in publicly traded US firms using a machine learning approach. *Journal of Accounting Research*, 58(1), 199-235.https://doi.org/10.1111/1475-679X.12292

Bassey, E., Mulligan, E. & Ojo, A. (2022). A conceptual framework for digital tax administration-A systematic review. *Government Information Quarterly*, 39(4), 101754. https://doi.org/10.1016/j.giq.2022.101754

Blanco, C.G-H. (2022). The use of Artificial Intelligence by tax administrations, a matter of principles. Available at: https://www.ciat.org/the-use-of-artificial-intelligence-by-tax-administrations-a-matter-of-principles/?lang=en

Cockfield, A. (2010). Protecting taxpayer privacy rights under enhanced cross-border tax information exchange: Toward a multilateral taxpayer Bill of Rights. University of British Columbia Law Review, 42(2), 421 Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1356841

Cockfield, A. (2016). Big Data and tax heaven secrecy. Florida Tax Review, 18, 483-539. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2757268

Collosa, A. (2020). Artificial intelligence in tax administrations: Benefits and risks of its use. Available at: https://www.gccfintax.com/articles/artificial-intelligence-in-tax-administrations-benefits-and-risks-of-its-use-1685.asp

Collosa, A. (2022). Artificial Intelligence in tax administrations. Available at: https://www.ciat.org/artificial-intelligence-in-tax-administrations/?lang=en

Commerford, B.P., Dennis, S.A., Joe, J.R. & Ulla, J.W. (2022). Man versus machine: Complex estimates and auditor reliance on artificial intelligence. *Journal of Accounting Research*, 60(1), 171-201. https://doi.org/10.1111/1475-679X.12407

Deloitte (2019). Our digital future: A perspective for tax professionals. https://www2.deloitte.com/za/en/pages/tax/articles/our-digital-future.html

Dickey, G, Blanke, S. & Seaton, L. (2019) Machine learning in auditing. *The CPA Journal,* June 2019*,* 16-21. Available at: https://www.cpajournal.com/2019/06/19/machine-learning-in-auditing/

Dietvorst, B.J. & Bharti, S. (2020). People reject algorithms in uncertain decision domains because they have diminishing sensitivity to forecasting error. *Psychological science*, 31(10), 1302-1314. https://doi.org/10.1177/0956797620948841

Faúndez-Ugalde, A., Mellado-Silva, R. & Aldunate-Lizana, E. (2020). Use of artificial intelligence by tax administrations: An analysis regarding taxpayers' rights in Latin American countries. *Computer Law & Security Review*, 38, 105441. https://doi.org/10.1016/j.clrs.2020.105441

Fügener, A., Grahl, J., Gupta, A. & Ketter, W. (2021). Cognitive challenges in human–Artificial Intelligence collaboration: Investigating the path toward productive delegation. *Information Systems Research,* 33(2), 678-696. https://doi.org/10.1287/isre.2021.1079

Granger, J., de Clercq, B. & Lymer, A. (2022). Tapping taxes. Digital disruption and Revenue Administration responses. In *Taxation in the digital economy*, Routledge, 21-44. https://doi.org/10.4324/9781003196020-3

Hassan, R.A.B. (2023). Determinant Factors of Tax Digitalization Adoption: Towards Sustainable Tax Profession. In *Proceedings of International Conference on Economics Business and Government Challenges,* 6(1), 164-176.

Holmes, D. (2017). Big data: a very short introduction. Oxford: Oxford University Press. https://doi.org/10.1093/actrade/9780198779575.001.0001

Huang, Z. (2018), Discussion on the development of Artificial Intelligence in taxation. *American Journal of Industrial and Business Management*, 8(8), 1817-1824 https://doi.org/10.4236/ajibm.2018.88123

Ihnatišinová, D. (2021) Digitalization of tax administration communication under the effect of global megatrends of the digital age. SHS Web of Conferences 92, 0 (2021) Globalization and its Socio-Economic Consequences 2020 https://doi.org/10.1051/shsconf/20219202022

Issa, H., Sun, T. & Vasarhelyi, M.A. (2016). Research ideas for artificial intelligence in auditing: The formalization of audit and workforce supplementation. *Journal of Emerging Technologies in Accounting,* 13(2), 1-20. https://doi.org/10.2308/jeta-10511

Julius, K. & Christabel, M. (2020). Effectiveness and efficiency of artificial intelligence in boosting customs performance: A case study of RECTS at Uganda Customs administration. *World Customs Journal*, 14(2), 177-192. https://doi.org/10.55596/001c.116426

Junquera-Varela, R.F., Lucas-Mas, C.O., Krsul, I., Calderon Yksic, V.O. & Arce Rodriguez, P. (2022). Digital transformation of tax and customs administrations. Available at: https://documents1.worldbank.org/curated/en/099448206302236597/pdf/IDU0e1ffd10c0c208047a30926c08259ec3064e4.pdf

Kamil, I. (2022). Influence Artificial Intelligence Technology for E-filling and Digital Service Tax (DST) in Tax Administration on Tax Compliance. *International Journal of Management Studies and Social Science Research*, 4(1), 144-156. Available at: https://ijmsssr.org/paper/IJMSSSR00616.pdf

Kifordu, B.C. (2021) Machine Learning in Tax administration: A case study of Nigeria. Master Thesis, Tallinn University of Technology. Available at: https://digikogu.taltech.ee/en/Download/b65fee52-1cf3-4d17-9601-6dc4829a1f87

Kumar, R., Malholtra, R.K. & Grover, C.N. (2023). Review on Artificial Intelligence Role in Implementation of Goods and Services Tax(GST) and Future Scope. In *2023 International Conference on Artificial Intelligence and Smart Communication (AISC)*, Greater Noida, India, 2023, 348-351. https://doi.org/10.1109/AISC56616.2023.10085030

Landers, R.N. & Behrend, T.S. (2022). Auditing the AI auditors: A framework for evaluating fairness and bias in high stakes AI predictive models. *American Psychologist,* 78(1), 36–49. https://doi.org/10.1037/amp0000972

Masseno, M.D. (2020). Na borda: dados pessoais e não pessoais nos dois regulamentos da União Europeia. *Disciplinarum Scientia | Sociais Aplicadas*, *16*(1), 41–55. Available at: https://periodicos.ufn.edu.br/index.php/disciplinarumSA/article/view/3095

Mhlanga, D. (2023). Exploring the evolution of Artificial Intelligence and the fourth industrial revolution: an overview. In: *FinTech and Artificial Intelligence for*

Sustainable Development. Sustainable Development Goals Series. Palgrave Macmillan, Cham., 15-39. https://doi.org/10.1007/978-3-031-37776-1_2

Mhlanga, D. &Ndhlovu, E. (2023). The Fourth Industrial Revolution in Africa: An Introduction. In: Mhlanga, D., Ndhlovu, E. (eds) *The Fourth Industrial Revolution in Africa. Advances in African Economic, Social and Political Development.* Springer, Cham., 1-12. https://doi.org/10.1007/978-3-031-28686-5_1

Millan Vargas, A. & Sandoval-Almazán, R. (2024). Public managers perception on artificial intelligence: the case of the State of Mexico. Proceedings of the 57th Hawaii International Conference on System Sciences. 1860-1869. Available at: https://www.researchgate.net/publication/377267550_Public_managers_perception_on_artificial_intelligence_the_case_of_the_State_of_Mexico

Moloi, T., Marwala, T. (2021a). Robotic Process Automation in Strategy and Strategy Implementation. In: *Artificial Intelligence and the Changing Nature of Corporations. Future of Business and Finance*. Springer, Cham., 97-104. https://doi.org/10.1007/978-3-030-76313-8_7

Moloi, T. & Marwala, T. (2021b). Natural Language Processing in Strategy and Implementation. In: Artificial Intelligence and the Changing Nature of Corporations. Future of Business and Finance. Springer, Cham.. 77-95. https://doi.org/10.1007/978-3-030-76313-8_6

Moodley, N (2024). How SARS used AI and proactive measures to claw back R210bn this tax year. *Daily Maverick.* Available at: https://www.dailymaverick.co.za/article/2024-02-26-how-sars-used-ai-and-proactive-measures-to-claw-back-r210bn-this-tax-year/

Mpofu, F.Y.S. (2021a). Taxing the informal sector through presumptive taxes in Zimbabwe: An avenue for a broadened tax base, stifling of the informal sector activities or both. *Journal of Accounting and Taxation*, 13(3), 153-177. https://doi.org/10.5897/JAT2021.0469

Mpofu, F.Y. (2021b). Review Articles: A critical review of the pitfalls and guidelines to effectively conducting and reporting reviews. *Technium Social Science Journal*, 18, 550-574. Available at: https://techniumscience.com/index.php/socialsciences/article/view/3034

Mpofu, F.Y. (2021c). Addressing the saturation attainment controversy: Evidence from the qualitative research on assessing the feasibility of informal sector taxation in Zimbabwe. *Technium Social Science Journal*, 19, 607-630. Available at: https://techniumscience.com/index.php/socialsciences/article/view/3307

Mpofu, F.Y. (2022a). Industry 4.0 in financial services: Mobile money taxes, revenue mobilisation, financial inclusion, and the realisation of sustainable development goals (SDGs) in Africa. *Sustainability*, 14(14), 8667. https://doi.org/10.3390/su14148667

Mpofu, F.Y (2022b). Sustainable mobilisation of tax revenues to enhance economic growth in Sub-Saharan Africa: Challenges, opportunities, and possible areas of reform. *International Journal of Research in Business and Social Science*, 11(9), 222-233. https://doi.org/10.20525/ijrbs.v11i9.2106

Mpofu, F.Y. (2023a). The application of Artificial Intelligence in external auditing and its implications on audit quality? A review of the ongoing debates. *International Journal of Research in Business and Social Science*, 12(9), 496–512. https://doi.org/10.20525/ijrbs.v12i9.2737

Mpofu, F.Y. (2023b). Fintech, the fourth industrial revolution technologies, digital financial services and the advancement of the SDGs in developing countries. *International Journal of Social Science Research and Review*, 6(1), 533-553. https://doi.org/10.47814/ijssrr.v6i1.752

Mpofu, F.Y. & Moloi, T. (2022). Direct digital services taxes in Africa and the canons of taxation. *Laws*, 11(4), 57. https://doi.org/10.3390/laws11040057

Mpofu, F.Y. & Wealth, E. (2022). The arm's length principle: a panacea or problem to regulating transfer pricing transactions by MNES in developing countries. *Eurasian Journal of Business and Management*, *10*(2), 137-152. https://doi.org/10.15604/ejbm.2022.10.02.004

Munoko, I., Brown-Liburd, H.L. & Vasarhelyi, M. (2020). The ethical implications of using artificial intelligence in auditing. *Journal of Business Ethics*, 167(2), 209-234. https://doi.org/10.1007/s10551-019-04407-1

Murorunkwere, B. F., Tuyishimire, O., Haughton, D., & Nzabanita, J. (2022). Fraud detection using neural networks: A case study of income tax. *Future Internet*, *14*(6), 168.

Nugraha, R. (2023). Beyond automation: Unleashing the future of Artificial Intelligence in Indonesian tax administration. In *Seminar Nasional Institut STIAMI,* 10(3), 4-13. Available at: https://ojs.stiami.ac.id/index.php/PS/article/view/3444/1694

OECD (2019a). Artificial intelligence: How can we ensure that AI benefits society as a whole? Available at: https://www.oecd.org/digital/artificial-intelligence/

OECD (2019b). Artificial Intelligence: OECD Principles: How governments and other actors can shape a human-centric approach to trustworthy AI. Available at: `https://www.oecd.org/digital/artificial-intelligence/

OECD (2022a). Tax administrations continue to accelerate their digital transformation. Available at: https://www.oecd.org/tax/administration/tax-administrations-continue-to-accelerate-their-digital-transformation.htm

OECD (2022b). Tax Administration 2022: Comparative Information on OECD and other Advanced and Emerging Economies, OECD Publishing, Paris. Available at: https://www.oecd.org/tax/forum-on-tax-administration/publications-and-products/tax-administration-23077727.htm

Oeta, A.N. (2017). iTax and Revenue Collection by Kenya Revenue Authority In Western Region, Kenya, Doctoral dissertation, University of Nairobi. Available at: http://erepository.uonbi.ac.ke/bitstream/handle/11295/103219/Oeta_iTax%20and%20Revenue%20Collection%20By%20Kenya%20Revenue%20Authority%20In%20Western%20Region%2C%20Kenya.pdf

Owens, J. & Schlenther, B. (2022). Developments in the use of technologies in African tax administrations. *African Multidisciplinary Tax Journal*, 1, 1-22. https://doi.org/10.47348/AMTJ/V2/i1a1

Pavlova, K.S. & Knyazeva, N.V. (2021). Specific Features of Taxation for Foreign Companies Receiving Income from Russian Sources. In: *Ashmarina, S., Mantulenko, V., Vochozka, M. (eds) Engineering Economics: Decisions and Solutions from Eurasian Perspective. ENGINEERING ECONOMICS WEEK 2020. Lecture Notes in Networks and Systems*, vol 139, 311-317. Springer, Cham. https://doi.org/10.1007/978-3-030-53277-2_37

Pica, L. (2023). The new challenges of Artificial Intelligence, profiling and bigdata analysis by tax administrations: Will the right to meet these new challenges be shown?. *JusGov Research Paper no.*2023-04. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4401050#

Rahayu, S.K. (2021). Utilization of artificial intelligence in tax audit in Indonesia. *Management and Accounting Review*, 20(3), 135-157. Available at: https://ir.uitm.edu.my/id/eprint/61675/1/61675.pdf

Rathi, A., Sharma, S., Lodha, G. & Srivastava, M. (2021). A study on application of artificial intelligence and machine learning in indian taxation system. *Psychology and Education Journal*, 58(2), 1226-1233. https://doi.org/10.17762/pae.v58i2.2265

Rogan, M. (2019). Tax Justice and the Informal Economy. WIEGO Working Paper no.14. Available at: https://www.wiego.org/sites/default/files/publications/file/Rogan_Taxation_Debates_WIEGO_WorkingPaperNo41_2020.pdf

Santiso, C. (2022). Trust with integrity: Harnessing the integrity dividends of digital government for reducing corruption in developing countries. United Nations, Department of Economic and Social Affairs (DESA), Working paper no.176, ST/ESA/2022/DWP/176, available at: https://www.un.org/en/desa/trust-integrity-harnessing-integrity-dividends-digital-government-reducing-corruption

Saragih, A.H., Reyhani, Q., Setyowati, M.S. & Hendrawan, A. (2023). The potential of an artificial intelligence (AI) application for the tax administration system's modernization: the case of Indonesia. *Artificial Intelligence and Law*, 31(3), 491-514. https://doi.org/10.1007/s10506-022-09321-y

Shakil, M.H. & Tasnia, M. (2022). Artificial intelligence and tax administration in Asia and the Pacific. In *Taxation in the Digital Economy*. Routledge. 45-55. https://doi.org/10.4324/9781003196020-3

Sebele-Mpofu, F.Y. (2020). Governance quality and tax morale and compliance in Zimbabwe's informal sector. *Cogent Business & Management*, 7(1), 1794662. https://doi.org/10.1080/23311975.2020.1794662

Sebele-Mpofu, F.Y. (2021). The informal sector, the "implicit" social contract, the willingness to pay taxes, and tax compliance in Zimbabwe. *Accounting, Economics, and Law: A Convivium*, 13(3), 299-342. https://doi.org/10.1515/ael-2020-0084

Sebele-Mpofu, F. Y. & Moyo, N. (2021). An Evil to be Extinguished or a Resource to be harnessed-Informal Sector in developing countries: a case of Zimbabwe. *Journal of Economics and Behavioral Studies*, 13(3(J)), 53-72. https://doi.org/10.22610/jebs.v13i3(J).3154

Serrano Antón, F. (2021) Artificial Intelligence and Tax Administration: Strategy, Applications, and Implications, with Special Reference to the Tax Inspection Procedure. In: *World tax journal. - Amsterdam*. 13(4), 575-608. Available at: https://ssrn.com/abstract=4223007

Susar, D. & Aquaro, V. (2019, April). Artificial Intelligence: Opportunities and challenges for the public sector. In ICEGOV'19. *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance,* 418-426. https://doi.org/10.1145/3326365.3326420

Twesige, D., Gshejaa, F., Hategikimanaa, U., Ndikubwimanaa, P., Mwizaa, Y. & Hitayezua, I. (2020). Smart Taxation (4Taxation): Effect of Fourth Industrial Revolution (4IR) on tax compliance in Rwanda.. *Journal of Business and Administrative Studies*, 12(1), 1-27. Available at: https://www.ajol.info/index.php/jbas/article/view/268602

UNDP (2022). Artificial Intelligence and Big Data for Increasing Tax Collections in Tanzania's MSMEs. Digital Transformation in Tax Administration. Available at: https://documents1.worldbank.org/curated/en/099448206302236597/pdf/IDU0e1ffd10c0c208047a30926c08259ec3064e4.pdf

Van Rooi, B. (2023). *The potential impact of the 4IR on Tax Administration in South Africa* (Doctoral dissertation, University of Johannesburg). https://ujcontent.uj.ac.za/view/pdfCoverPage?instCode=27UOJ_INST&filePid=139649460007691&download=true

Wakefield, A. (2015). Synthesising the literature as part of a literature review. *Nursing standard: official newspaper of the Royal College of Nursing*, 29(29), 44-51. https://doi.org/10.7748/ns.29.29.44.e8957

Walker, B. (2019). Facilitating SDGs by tax system reform. In Walker, J., Pekmezovic, A., Walker, G. (eds) *Sustainable Development Goals: Harnessing Business to Achieve the SDGs through Finance, Technology, and Law Reform*, 303-316. https://doi.org/10.1002/9781119541851.ch17

Wealth, E., Smulders, S.A. & Mpofu, F.Y. (2023). Conceptualising the behaviour of MNEs, tax authorities and tax consultants in respect of transfer pricing practices – A three-layer analysis. *Accounting, Economics, and Law: A Convivium*, https://doi.org/10.1515/ael-2022-0036

Zafar, A. & Villeneuve, S. (2018). Adopting AI in the Public Sector: Turning risks into opportunities through thoughtful design. ICEGOV '19: Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance. 418-426. https://doi.org/10.1145/3326365.3326420

Zhang, M. (2020). Practical thinking on the new tax service in the era of artificial intelligence. In *2020 International Conference on E-Commerce and Internet Technology (ECIT),* Zhangjiajie, China, 201-203. https://doi.org/10.1109/ECIT50008.2020.00052

Zhou, L (2019). Opportunities and Challenges of Artificial Intelligence. In Proceedings of the 2019 International Conference on Economic Management and Cultural Industry (ICEMCI 2019). https://doi.org/10.2991/aebmr.k.191217.038

Zumaya, M., Guerrero, R., Islas, E., Pineda, O., Gershenson, C., Iñiguez, G. & Pineda, C. (2021). Identifying tax evasion in Mexico with tools from network science and machine learning. In: Granados, O.M., Nicolás-Carlock, J.R. (eds) Corruption Networks. Understanding Complex Systems. Springer, Cham, 89-113. https://doi.org/10.1007/978-3-030-81484-7_6

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ENVIRONMENTAL PERFORMANCE AND PRESS FREEDOM WITHIN AN ECONOMICAL FRAMEWORK

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ABSTRACT. The purpose of this work is to investigate novel determinant factors of environmental performance such as press freedom and voice and accountability. Having reviewed the specialized literature in this field, one can observe and analyse the differentiated magnitude of the impact press freedom imprints on the Environmental Performance Index and the greenhouse gas emissions on the other, for a generous sample of countries, according to their development levels: high income, upper middle income, lower-middle income and low-income countries. The results support the positive effect of press freedom upon lowering greenhouse gas emissions and improving the overall environmental performance of nations, particularly for the subsample of low-income countries. The current findings are robust to several proxies and control variables.

Keywords: environmental quality, press freedom, income levels, public governance, panel data analysis

JEL classifications: Q56, O44, K32

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Introduction and review of literature

Delving into the complexity of climate change, after an outburst in the normality of humanity itself, an accelerated trend of severe concerns has started to question the wellbeing of the worldwide nations. The devastating results of the meteorological disruptions highlight the importance of becoming aware of the negative effects that arise upon the health of the ecosystems and humankind, mainly caused by greenhouse gases that are constantly being released into the atmosphere after the burning of fossil fuels and other industrial activities. The science behind this phenomenon of climate change is similar to a disease of the Earth, waiting to be cured with considerable action, facing uncertainties in observing the major contributors that lead to negative environmental changes (Wei et al., 2016). Being the most pressing issue of these times, it challenges the way of living, forcing humanity to rethink its actions and embrace sustainable living as a prosperous solution that will mitigate globally the effects of climate changes. A pivotal impact in overcoming the fight against the challenges posed by climate factors, implies a sharing sense of awareness and responsibility among societies. Shaping the desired future for the following generations lies in continuous engagement and action to protect the environment. Commonly referred as the fourth estate, the press has a major position in the societies due to its power of influence regarding the policy decisions, uncovering misconduct and giving a voice to new perspectives that aim to educate the citizens (Butler et al., 2018) by promoting civic engagement and welfare. It helps cultivating information by bringing concerns to the forefront, which is essential for facing the challenges from nowadays. Climate change is a vast and serious matter, not easily understood until reported all over the media, which makes it available for people to draw information and debate the possible causes and solutions (Schäfer, 2015).

The objective of this paper is to analyse the nexus between press freedom and environmental performances, for a generous sample of worldwide countries. The authors' interest is in the effect novel determinants such as media freedom and voice and accountability have upon the environmental performances of nations, as it is known media can support a lot of climate change actions, increasing climate awareness of the people. This underscores the strong need for the press to thoroughly address the major issues produced by the climate change. The research of (Chan et al., 2021) highlights that a robust media focus on environmental topics can drive meaningful public and policy engagement.

It cannot be denied that the power and liberty of the press has a major impact upon the climate change underscored by the environmental performance, blaming the lack of interest of societies, in rapidly mitigating some serious concerns that affect the nations in terms of sustainability and economic performance, with substantial uncertainty surrounding the shifts in extreme weather events by the end of this century (Thornton et al., 2014). The unconsciousness of nations is encountered especially in the poorest nations where the income inequality exacerbates the CO2 emissions (Baloch & Danish, 2022; Danish et al., 2022), where air pollution is ranked among the top risk factors for mortality (Ritchie & Roser, 2017), whereas the media is so crucial in lightening the environmental issues (Anderson, 2011) while pushing for adopting greener and durable solutions that will improve the wellness of humankind. News about climate change rarely appears in the media and when it does, it often frames climate change as an international concern rather than focusing on its local impact (López et al., 2020). As the level of urbanization also leads to an increase in environmental pollution (Muhammad & Khan, 2021), wealthier nations must also be accountable, not only by reducing their own emissions but by investing in affordable technologies that also support sustainable development in the less developed and developing countries so that they are not forced to choose between reducing poverty or keeping a low level of emissions (Ritchie et al., 2023). An important insight from the study of Hase et al. (2021) is that the media in the Global North tends to provide more coverage of the climate change, while in the Global South, which is more likely to focus on practical implications, are more emphasized the impacts and challenges posed by the phenomenon and this suggests some regional differences in prioritizing the climate change concern. Ensuring that all voices are heard and holding accountable the highest polluting nations are key to achieving equitable and effective climate action. Media freedom becomes a significant predictor of polluting the air levels (Hswen et al., 2019), pointing out the higher importance and influence that the media has upon societies, in comparison to the environmental regulations (McCreery, 2010). The qualitative results of Wang et al. (2015) revealed that social media posts in China offer reliable firsthand accounts of the air quality across 74 cities, indicating that direct experiences with air quality significantly influence public behaviours and health concerns. Moreover, according to Harring et al. (2011), both economic conditions and content of the media independently influence public concern for environmental issues and health concerns while the tension between economic cycles and public environmental awareness appears to be diminishing. In societies where media operates without any restrictions, there is often greater political and social pressure for environmental responsibility and innovation, having as result improved environmental regulations (Agnone, 2007). Thus,

media freedom is a crucial enabler of the environmental direction, building a society that prioritizes sustainability as a lifestyle and holding individuals accountable for the protection and preservation of this living planet.

Having analysed the state of the art in this research field, it is fundament the following working hypothesis:

Increasing press freedom is related to increasing environmental performances.

The purpose of this work is to assess whether press freedom influences environmental performance in a different manner, according to the economic development levels of nations. Thus, it is stated the following research question:

How does press freedom impact environmental performances as a function of countries' income levels?

The remainder of this paper is organised as follows: section 2 describes the data and methodology that has been used, then section 3 presents the baseline results and discusses them, while section 4 concludes with policy implications and future research directions.

Materials and methods

The database used for this study covers a sample of 185 worldwide countries throughout the 2005-2022 time interval. It's an unbalanced panel data set, but it has been strived by the researchers to obtain the maximum number of observations per variable.

The main dependent variable covers several environmental performance proxies such as the Environmental Performance Index (denoted EPI), probably the most complex measure and also the greenhouse gas emissions (denoted Green) of nations. EPI reflects climate change performance, environmental health and ecosystem vitally scorecard as provided by Yale Center for Environmental Law & Policy (2024), being an aggregated indicator. In part, it includes Green, i.e. the total greenhouse gas emissions (kilotons of CO2 equivalent) as provided by World Bank (2024). Carbon dioxide emissions (denoted Emiss) as CO2 emissions (metric tons per capita), provided by World Bank (2023), are used for robustness checks.

The main independent variable covers press freedom proxies, such as the following: the Press Freedom Score (denoted PRESS_F) and the Voice and Accountability government indicator (denoted VA). PRESS_F is a global index that ranges from 0 to 100, with 100 being the best possible score as provided by Reporters without Borders (2024). VA is a World Governance dimension that reveals the extent to which citizens are able to participate in selecting their

government, as well as their freedom of expression and a free media. VA is scaled from -2.5 to 2.5 and it is provided by World Data Bank (2024), supporting its own methodology.

Control variables refer to the unemployment rate of nations (denoted Unempl, as a percentage measure of the total population of countries) and the urbanization rate (denoted Urban, as a percentage rate of the total population as well), both provided by World Data Bank (2024).

The summary statistics of the dataset, presented in Table 1., embrace a diverse landscape of social, economic and environmental conditions across different worldwide nations. Press Freedom (denoted PRESS_F) has a score that ranges from a low of 0 to a high of 100.03, with a mean of 68.29, suggesting a significant disparity in media freedom, where some regions experience total media suppression while others enjoy complete freedom. Voice and Accountability (denoted VA), an indicator of democratic governance and citizen involvement, has a mean slightly below zero at -0.11, with values spanning from -2.31 to 1.75, indicating that while some regions are highly democratic, others are facing severe limitations on political freedoms, not having the power to express freely.

The Environmental Performance Index (EPI), with an average of 52.24, has a wide range from 0 to 90.68, reflecting diverse environmental outcomes, with some nations achieving desirable results in terms of environmental performance, while others fall behind considerably. The proxy related to Carbon dioxide emissions (denoted Emiss) shows a mean of 4.35, with a minimum value of 0.02 and a maximum value of 45.41, indicating that while some regions have low emissions, others are significant contributors to global emissions. The greenhouse gas emissions variable (denoted Green), reflecting the vast contribution of polluting emissions upon climate change, has values ranging from as low as 80 to a staggering 12.7 kilotons of CO2 equivalent, pointing out differences in industrial activity and environmental impact among regions.

The Unemployment Rate (denoted Unempl) is extremely various, having a mean of 7.85 and ranging from a minimum score of 0.1 to a peak of 37.32, indicating that while some regions experience efficiency in the labor force, others face severe issues, lacking the jobs availability. Another variable, Urbanization (denoted Urban), with a mean average of 57.62 and extremes ranging from the lowest level of 9.38 to complete urbanization at the highest level of 100, spotlight the diverse stages of urban development.

Table 1. Summary statistics

Variable	Obs	Mean	Std. dev.	Min	Max
PRESS_F	2,896	68.2891	22.3036	0	100.0257
VA	3,131	-0.1118	0.9874	-2.3134	1.7517
EPI	2,986	52.2378	16.8302	0	90.6801
Emiss	2,700	4.3541	5.4298	0.0203	45.4101
Green	2,700	236558	966338	80	12700000
Unempl	3,041	7.8494	5.8048	0.1001	37.3202
Urban	3,111	57.6154	22.9415	9.375	100

Source: Author's processings in Stata 18

The correlation matrix is presented in Table 2, pointing out towards the direct or indirect relationships between the variables of interest.

Table 2. Correlation matrix

n=2439	EPI	Emiss	Green	PRESS_F	VA	Urban	Unempl
EPI	1						
Emiss	0.5106	1					
Green	0.0408	0.1331	1				
PRESS_F	0.3543	0.1144	-0.1919	1			
VA	0.6071	0.1864	-0.0469	0.8195	1		
Urban	0.6503	0.5998	0.0681	0.2303	0.3926	1	
Unempl	0.0026	-0.1053	-0.0612	0.0322	0.0208	0.0924	1

Source: Author's processings in Stata 18

The methodology of this study employs the pooled OLS models for panel data. It is used both simple and multiple regression modelling, the forward addition approach.

The baseline model is described by Equation (1). The main results use the addition of control variables to the baseline equation below.

$$\mathbf{EnvironmentalPerformance}_{it} = \beta_0 + \beta_1 \mathbf{PressFreedom}_{it} + \varepsilon_{it} \quad \text{Eq (1)}$$

Eq (1) estimates the effects of press freedom proxies upon the performance of the environment, using the notations below:

$EnvironmentalPerformance_{it}$ – various environmental performance proxies (EPI, Green, Emiss) of country *i* , year *t*;
β_0 - constant;
β_1- linear effect parameter;
$PressFreedom_{it}$ – press freedom proxies (PRESS_F, VA) of country *i*, year *t*;
ε_{it} - the residual.

Results and discussions

The outcomes of this study include the simple regression modelling of Equation (1). Table 3 estimates environmental performance proxied by EPI as a function of PRESS_F in Models (1) and VA in Models (2). Once Eq (1) is estimated, the vector of control variables (Urban and Unempl) is added to each baseline model. The main results from Table 3, for the full sample models, support a direct relationship between press freedom and environmental performance proxied by EPI: the higher the media freedom is, the more improved the performance of the environment is (positive estimated coefficients for PRESS_F and VA when explicating EPI).

Table 3. Environmental performance as a function of press freedom

OLS regression modelling of EPI, full sample				
	Model (1)	**Model (1) with added controls**	**Model (2)**	**Model (2) with added controls**
PRESS_F	0.2998***	0.1988***		
VA			9.9701***	7.2913***
Urban		0.4402***		0.3478***
Unempl		-0.2005***		-0.1829***
const	31.7232***	14.7321***	53.2751***	34.5296***
R^2	0.1473	0.4594	0.3393	0.5354
Adj R^2	0.147	0.4588	0.3391	0.5349
Obs.	2,814	2,777	2,978	2,890

Notes: *** Significant at the 0.01 level; ** Significant at the 0.05 level;
* Significant at the 0.10 level. Source: Author's processings in Stata 18

Table 4 estimates environmental performance proxied by Green as a function of PRESS_F in Models (1) and VA in Models (2) (Log-linear regressions). Once Eq (1) is estimated, the vector of control variables (Urban and Unempl) is added, to each model. All estimated coefficients of variables stay significant, keeping their signs and magnitudes. According to the results from Table 4, an indirect relationship between press freedom and greenhouse gas emissions is validated: the higher the media freedom is, the lower the greenhouse gas emissions are, thus the more improved the performance of the environment is (negative estimated coefficients for PRESS_F and VA, when explicating LogGreen).

Table 4. Greenhouse gas emissions as a function of press freedom

OLS regression modelling of LogGreen, full sample				
	Model (1)	**Model (1) with added controls**	**Model (2)**	**Model (2) with added controls**
PRESS_F	-0.0129***	-0.0196***		
VA			-0.1431***	-0.3399***
Urban		0.0342***		0.0373***
Unempl		-0.0518***		-0.0691***
const	11.5271***	10.4583***	10.3871***	8.8801***
R^2	0.0252	0.2131	0.0048	0.1964
Adj R^2	0.0248	0.2121	0.0044	0.1954
Obs.	2,503	2,488	2,688	2,628

Notes: *** Significant at the 0.01 level; ** Significant at the 0.05 level;
* Significant at the 0.10 level.
Source: Author's processings in Stata 18

To continue, and account for the heterogeneity of the sample, it has further been estimated Eq 1 with added control variables on subsamples of nations, according to World Data Bank (2024) income levels. The World Bank assigns the world's economies to four income groups: low (denoted L), lower-middle (denoted LM), upper-middle (denoted UM) and high income (denoted H) countries. Table 5 presents the estimations of EPI as a function of press freedom on subsamples of countries (H, UM, LM and L).

Table 5. Environmental performance as a function of press freedom, on subsamples

OLS regression modelling of EPI, subsamples								
	Model (1) with added controls for H	**Model (1) with added controls for UM**	**Model (1) with added controls for LM**	**Model (1) with added controls for L**	**Model (2) with added controls for H**	**Model (2) with added controls for UM**	**Model (2) with added controls for LM**	**Model (2) with added controls for L**
PRESS_F	0.0164	0.0079	0.0741***	0.3273***				
VA					1.2216***	1.1592***	2.6294***	7.3472***
Urban	-0.0684**	0.1714***	0.0504**	0.0915***	-0.0759**	0.1695***	0.0663***	0.1283***
Unempl	-0.3136***	-0.3626***	-0.2929***	0.3592***	-0.2801***	-0.3517***	-0.2696***	-0.0456
const	36.4207***	39.1866***	50.2302***	34.4356***	38.5434***	40.3283***	54.1973***	54.6627***
R^2	0.0373	0.0912	0.0498	0.3087	0.0442	0.097	0.072	0.3043
Adj R^2	0.0323	0.0876	0.0457	0.3059	0.0392	0.0935	0.0681	0.3017
Obs.	580	746	700	748	583	781	720	802

Notes: *** Significant at the 0.01 level; ** Significant at the 0.05 level;
* Significant at the 0.10 level.
Source: Author's processings in Stata 18

Table 5 contains the estimations of EPI as a function of PRESS_F (Models (1)), significant for the LM subsample of countries, with media freedom having a positive impact upon environmental performances. Then, for the L countries, the impact of press freedom on EPI is 4 times larger for L than for LM, thus the lower the development level of countries is, the more pronounced the impact of press freedom upon EPI is. Moreover, when estimating EPI as a function of VA (in Models (2)), its impact is 2 times larger for LM countries than for UM countries. Nonetheless, the impact of VA upon EPI is 3 times larger for L countries than for LM countries. It is thus validated the positive impact of media freedom upon environmental performance, with a larger magnitude for the lowest income countries, findings which are consistent with (Bathiany et al., 2018). Research on media coverage of climate change has focused on industrialized countries, leaving significant gaps in understanding how and when news media and journalists in developing countries are addressing the

concern (López et al., 2020). Already captured by the study of Boykoff (2014), a free press can amplify the voices and accountability of environmental reporters and scientists, bridging the gap between complex environmental data and public understanding.

Table 6 presents the estimations of greenhouse gas emissions as a function of press freedom (PRESS_F and VA) on subsamples of countries (H, UM, LM and L).

Table 6. Greenhouse gas emissions as a function of press freedom, on subsamples

OLS regression modelling of LogGreen, subsamples								
	Model (1) with added controls for H	**Model (1) with added controls for UM**	**Model (1) with added controls for LM**	**Model (1) with added controls for L**	**Model (2) with added controls for H**	**Model (2) with added controls for UM**	**Model (2) with added controls for LM**	**Model (2) with added controls for L**
PRESS_F	-0.0146***	-0.0395***	-0.0357***	-0.0013				
VA					-0.4889***	-1.1079***	-0.7897***	0.0174
Urban	-0.0151***	0.0248***	0.0456**	0.0166***	-0.0161***	0.0228***	-0.0526***	0.0219**
Unempl	-0.041***	-0.104***	-0.021**	0.0041	-0.0593***	-0.1183***	-0.0527***	-0.0182
const	11.4169***	12.5307***	10.5307***	10.1577***	10.1957***	9.5211***	7.7755***	9,6614**
R^2	0.0802	0.3055	0.3642	0.02	0.0942	0.2415	0.4042	0.0402
Adj R^2	0.0752	0.3023	0.3611	0.0155	0.0893	0.2383	0.4015	0.0361
Obs.	557	663	616	651	563	706	656	701

Notes: *** Significant at the 0.01 level; ** Significant at the 0.05 level;
* Significant at the 0.10 level.
Source: Author's processings in Stata 18

Consistent to the findings from Table 4, Table 6 validates the negative impact of press freedom upon greenhouse gas emissions, consistent to authors' research hypothesis as the larger the freedom of press is, the lower the greenhouse gas emissions are, thus the more performant the environment is. Although the estimated coefficients for the L subsample of countries are not significant, for the H subsample of countries one can clearly observe to have an

indirect effect of press freedom upon greenhouse gas emissions (Log-linear regressions). From models (1) there is noticed an about 3 times larger effect for UM than for H and an about 3 times larger effect for LM than for H. These estimations are supported by the ones for Models (2), which estimates LogGreen as a function of VA): when significant, there's an about 2.5 times larger effect for UM than for H while this impact is 1.5 times larger for LM than for H. Summing up, Table 6 clearly supports the negative impact of media freedom upon greenhouse gas emissions, with a larger magnitude for the upper middle-income countries, consistent with Ike et al. (2022) and Ritchie & Roser (2017) which reveal that the press freedom limits emissions in economies with smaller industry size but increases the emissions in economies with a larger industry.

These findings have important policy implications. It is underscored the firm belief that governments should act upon the freedom of press particularly in lower income countries, in order to attain improved effects on greenhouse gas emissions and environmental performance. This also answers the research question, thus urgent actions are required for raising climate awareness through the instruments the media holds, particularly in lower middle and low-income countries, for this enhanced leverage effect.

Conclusions

This paper tests press freedom as a rather new determinant of environmental performance of worldwide countries. The research hypothesis is validated, according to which increasing media freedom is related to increasing environmental performances, for most subsamples of income levelled countries, estimations which are stable to various press freedom proxies and added control variables. This suggests that when the media is free to operate without restrictions, it has a higher impact upon the public accountability leading to increased action in adopting sustainable practices, even though some nations are still in the early stages of recognizing and embracing sustainable sources (Umar & Egbu, 2019). Moreover, there is an opportunity to be more educated and well informed with a proper accessibility to the content of media, which can provide crucial skills for a democratic participation in the environmental policies (Chan et al., 2021), advocating for sustainable solutions that may lead to desirable outcomes.

The highlights of this study suggest a direct relationship between press freedom and environmental performance, as measured by the Environmental Performance Index (EPI): more media freedom is generally associated with better environmental outcomes. Additionally, there is an indirect relationship between press freedom and greenhouse gas emissions, with increased media freedom leading to a reduction in the emissions which will further enhance the environmental performance. Ensuring a supportive attitude of the governments among prioritizing the protection and freedom of the press, it can lead to beneficial action and increased public awareness regarding the gravity of the environmental issues.

During periods of economic downturn, people often prioritize other matters, especially the financial challenges over environmental concerns, while in contrast, when the economy is doing well, there is generally a greater focus on environmental degradation (McCreery, 2010; Harring et al., 2011; Patel et al., 2023). Moreover, heightened media freedom to cover environmental issues generally boosts public concern for the environment. However, it was demonstrated a clear alignment with the trend towards environmental sustainability, reflecting systematic empirical evidence in public opinion. Consistent with previous observations, the study of Harring et al. (2011) also revealed that both economic conditions and media content independently influence the public concern for environmental issues. Conversely, increased media coverage of environmental issues generally increases the public awareness. Each factor operates separately, affecting how the public perceives and prioritizes environmental issues. The influence of media on societies, when compared to the impact of environmental regulations, is significant and multifaceted (McCreery, 2010). While environmental regulations are crucial for enforcing standards and promoting sustainable practices, media coverage has the ability to shape public perceptions and priorities. Governments should also endorse programs that equip the journalists with the necessary training and help them with resources to report effectively the environmental concerns, while ensuring that the public has access to and completely understands this information. These initiatives can empower citizens to contribute significantly, leading to enhanced environmental outcomes and increased resilience to ecological threats. In this way, nations can develop an informed and engaged population that acts a vital role in global sustainability, fighting against the climate change. The industrialized countries that have produced the majority of greenhouse gas emissions are typically the least vulnerable to the effects of climate change (Alcamo & Olesen, 2012), while the less industrialized nations are more prone to becoming pollution havens (Alhassan et al., 2020). Wealthy nations must separate their consumption practices from harming the environment, leveraging their resources to support the sustainable development of poorer

nations (Block et al., 2024). The main focus of the governments should be especially on the poorest nations where the mortality risk is tremendous due to environmental pollution (Ritchie & Roser, 2017), which are highly disadvantaged in terms of having access to vital news and other materials from the media, due to the lack of internet and financial resources.

While these findings are promising, there were encountered some limitations in the study that must be acknowledged. The limits include the lack of validation for carbon dioxide emissions as another environmental quality proxy and the challenging task of missing observations. Considering the aim for future studies fostering continuous advancement, the tendency is to follow these research directions and also address some new objectives: the inclusion of more control variables; different methodologies (Fixed vs random effects modelling, Quantile regression approach); the use of dummies.

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REFERENCES

Agnone, J. (2007). Amplifying public opinion: The policy impact of the US environmental movement. *Social Forces*, 85(4), 1593-1620. https://doi.org/10.1353/sof.2007.0059

Alcamo, J. & Olesen, J.E. (2012). Climate and climate change. In Alcamo, J., & Olesen, J. E. (eds) Life in Europe under climate change, Wiley Online Library. https://doi.org/10.1002/9781118279380.ch2

Anderson, A. (2011). Sources, media, and modes of climate change communication: the role of celebrities. *Wiley Interdisciplinary Reviews: Climate Change*, 2(4), 535-546. https://doi.org/10.1002/wcc.119

Alhassan, A., Usman, O., Ike, G.N. & Sarkodie, S.A. (2020). Impact assessment of trade on environmental performance: Accounting for the role of government integrity and economic development in 79 countries. *Heliyon, 6*(9), e05046. https://doi.org/10.1016/j.heliyon.2020.e05046

Baloch, M.A. & Danish. (2022). The nexus between renewable energy, income inequality, and consumption-based CO2 emissions: An empirical investigation. *Sustainable Development*. Advance online publication. https://doi.org/10.1002/sd.2315

Bathiany, S., Dakos, V., Scheffer, M. & Lenton, T.M. (2018). Climate models predict increasing temperature variability in poor countries. *Science Advances, 4*(5), eaar5809. https://doi.org/10.1126/sciadv.aar5809

Block, S., Emerson, J.W., Esty, D.C., de Sherbinin, A., Wendling, Z.A. *et al.* (2024). *2024 Environmental Performance Index.* New Haven, provided by Yale Center for Environmental Law & Policy (2024). Available at https://epi.yale.edu (accessed on December 22nd, 2023)

Boykoff, M. (2014). Media discourse on the climate slowdown, *Nature Climate Change*, 4, 156–158. https://doi.org/10.1038/nclimate2156

Butler, A., Fuentes-Bautista, M. & Scharrer, E. (2018). Building media literacy in higher education. In Cubbage, J. (Ed.), *Handbook of Research on Media Literacy in Higher Education Environments*, IGI Global, Hershey, PA, 153–171. https://doi.org/10.4018/978-1-5225-4059-5.ch009

Chan, M., Lee, F.L.F. & Chen, H.T. (2021). Examining the roles of multi-platform social media news use, engagement, and connections with news organizations and journalists on news literacy: A comparison of seven democracies. *Digital Journalism*, 9(5), 571–588. https://doi.org/10.1080/21670811.2021.1890168

Danish, M.A.B. & Zhang, J. (2022). Analyzing environmental impact assessment of income inequality, globalization, and growth in sub-Saharan African countries, *Environmental Science and Pollution Research*, 30(5), 1268-1277. https://doi.org/10.1007/s11356-022-24084-4

Hase, V., Mahl, D., Schäfer, M. S. & Keller, T.R. (2021). Climate change in news media across the globe: An automated analysis of issue attention and themes in climate change coverage in 10 countries (2006–2018). *Global Environmental Change, 70*, 102353. https://doi.org/10.1016/j.gloenvcha.2021.102353

Harring, N., Jagers, S.C. & Martinsson, J. (2011). Explaining ups and downs in the public's environmental concern in Sweden: the effects of ecological modernization, the economy, and the media. *Organization & Environment*, 24(4), 388-403. https://doi.org/10.1177/1086026611420300

Hswen, Y., Qin, Q., Brownstein, J.S. & Hawkins, J.B. (2019). Feasibility of using social media to monitor outdoor air pollution in London, England. *Preventive Medicine*, 121, 86-93. https://doi.org/10.1016/j.ypmed.2019.02.005

Ike, G.N., Jaff, Y.D. & Aghazadeh, S. (2022). An empirical analysis of the global environmental impact of press freedom: The role of internet access and industry size in 153 countries, *Journal of Cleaner Production*, 339, 130719. https://doi.org/10.1016/j.jclepro.2022.130719

López, M.S., Santi, M.F., Müller, G.V., Gómez, A.A., Staffolani, C. & Aragones Pomares, L. (2020). Climate change communication by the local digital press in Northeastern Argentina: An ethical analysis, *Science of The Total Environment*, 707, 135737. https://doi.org/10.1016/j.scitotenv.2019.135737

McCreery, A.C. (2010). Media attention, political processes, and air pollution in the United States: a time-series analysis (1959–1998). *Organization & Environment*, 23(3), 255–270. DOI: https://doi.org/10.1177/1086026610382619

Muhammad, B. & Khan, S. (2021). Understanding the relationship between natural resources, renewable energy consumption, economic factors, globalization and CO2 emissions in developed and developing countries. *Natural Resources Forum (NRF)*, 45(2), 138-156. https://doi.org/10.1111/1477-8947.12220

Patel, N., Kautish, P. & Shahbaz, M. (2023). Unveiling the complexities of sustainable development: An investigation of economic growth, globalization and human development on carbon emissions in 64 countries, *Sustainable Development,* 32(4), 3612-3639. https://doi.org/10.1002/sd.2846

Reporters without Borders (2024), World Press Freedom Index. Available at https://rsf.org/en/2023-world-press-freedom-index-journalism-threatened-fake-content-industry (accessed on December 22nd, 2023)

Ritchie, H., Rosado, P. & Roser, M. (2023). Per capita, national, historical: How do countries compare on CO2 metrics? *Our World in Data*. Available at https://ourworldindata.org/co2-emissions-metrics (accessed on April 6th, 2024)

Ritchie, H. & Roser, M. (2017). Air pollution. Available at: https://ourworldindata.org/air-pollution (accessed on July 18th, 2024)

Schäfer, M S. (2015). Climate Change and the Media. *International Encyclopedia of the Social & Behavioral Sciences (Second Edition)*, 853-859. https://doi.org/10.1016/B978-0-08-097086-8.91079-1

Thornton, P.K., Ericksen, P.J., Herrero, M. & Challinor, A.J. (2014). Climate variability and vulnerability to climate change: a review. *Global Change Biology*, 20(11), 3313-3328. https://doi.org/10.1111/gcb.12581

Umar, T. & Egbu, C. (2019). Global commitment towards sustainable energy. *Proceedings of the Institution of Civil Engineers – Engineering Sustainability*, 172(6), 315-323. https://doi.org/10.1680/jensu.17.00059

Wang, S., Paul, M. J. & Dredze, M. (2015). Social media as a sensor of air quality and public response in China. *Journal of Medical Internet Research*, 17(3), e22. https://doi.org/10.2196/jmir.3875

Wei, T., Dong, W., Yan, Q., Chou, J., Yang, Z. & Tian, D. (2016). Developed and developing world contributions to climate system change based on carbon dioxide, methane and nitrous oxide emissions. *Advances in Atmospheric Sciences,* 33, 632-643. https://doi.org/10.1007/s00376-015-5141-4

World Data Bank (2024). "World Bank Country and Lending Groups. World Bank Atlas Method." Available at https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups (accessed on March 15th, 2024) and World Bank Daabases. Available at https://data.worldbank.com (accessed on January 19th, 2024).