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Sustainable Social Development

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Prof. Kittisak Jermisittiparsert

University of City Island

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Editorial

ESG and sustainable development

Alexey Yurievich Mikhaylov

Institute of China and Contemporary Asia of the Russian Academy of Sciences, Leninsky Prospekt 14, 119991 Moscow, Russia

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People's expectations for businesses' social responsibility are rising as environmental and social issues are gaining more and more concerns worldwide. Furthermore, many big businesses need to take ESG (Environmental, Social, and Governance) factors into account when making decisions due to the growing trend of influence investing [1]. What is ESG? What's the advantage of ESG? What's the relationship between ESG and sustainable development? These questions will be answered in this article.

ESG is a set of criteria used to evaluate the environmental, social, and governance of corporates [2]. In particular, "Environmental" encompasses factors like greenhouse gas emissions, energy efficiency, waste management, and water conservation; "Social" will address how businesses interact with communities and employees, including human rights, employee diversity, labor standards, and supply chain management; and "Governance" will address how businesses operate and make sure their actions serve stakeholders' interests, including board diversity, compensation, risk management, and ethics [2]. In today's dynamic global economy, the incorporation of ESG considerations into corporate decision-making and investment approaches, along with an increased focus on ESG disclosures, has become a prominent and widely acknowledged trend [3], which is helpful for achieving longer-term and more scientific development of enterprises, thereby bringing more value to society.

ESG is one of the main drivers of corporate long-term value, leading to larger and more sustainable future profits [4]. Since today's investors show an increasing concern about the sustainability of enterprises, it is necessary to integrate ESG factors and indicators into the investment decision-making process. In the latest issue of the journal, *Sustainable Social Development*, Yap et al. [5] published an article on ESG, and they identified three advantages of embracing ESG into corporate finance based on the literature reviewed. First, it positively influences financial investment decisions; second, it can leverage advancements in technology and innovations; and third, it can create proactive risk management. Additionally, ESG investments could improve sustainable growth [3]. It can be indicated that ESG serves as an effective tool for the long-term and sustainable development of enterprises.

ESG and sustainable development are different concepts. However, there are some similarities between them. At some extent, ESG draws a direct connection with the SDGs' concept of creating "shared value" that involves finding mutually beneficial ways to align market potential, societal demands, and policy action to promote sustainable and inclusive economic growth and well-being [6].

All things considered, adding ESG indicators to business evaluation criteria can not only increase revenues for businesses but also have positive effects on human society and the environment. It is thought that when ESG becomes a more popular

standard, the objective of sustainable development will be more successfully attained and business development will become more rational and scientific [7–11].

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References

1. Sustainable growth with ESG. Available online: <https://www.velotrade.com/blog/esg-sustainable-growth/> (accessed on 25 April 2024).
2. HSBC. Sustainability vs ESG: What's the difference and why they matter [Series 1 of 4]. Available online: <https://www.businessgo.hsbc.com/en/article/demystifying-sustainability-and-esg> (accessed on 25 April 2024).
3. Bagh T, Zhou B, Alawi SM, Azam RI. ESG resilience: Exploring the non-linear effects of ESG performance on firms sustainable growth. *Research in International Business and Finance*. 2024, 70(A): 102305. doi: 10.1016/j.ribaf.2024.102305
4. Edman A. The end of ESG. *Financial Management*. 2023, 52(1): 3-17. doi: 10.2139/ssrn.4221990
5. Yap CK, Leow CS, Ismail AP. Environmental finance under ESG: A literature review and synthesis. *Sustainable Social Development*. 2024, 2(2): 2481. doi: 10.54517/ssd.v2i2.2481
6. Sustainability House. ESG and SDGs: Exploring the relationship. Available online: <https://www.sustainability-house.com/post/esg-and-sdgs-exploring-the-relationship> (accessed on 25 April 2024).
7. Dinçer H, Yüksel S, Eti S, et al. Effective waste management in service industry: Fuzzy-based modelling approach for strategic decision-making. *Waste Management & Research*. 2024. doi: 10.1177/0734242X241242682
8. Mikhaylov A, Chang T, Mukhanova A, et al. Applying theorem of ross to transition probability matrix in energy options pricing after political tensions and Russia-Ukraine conflict. *Energy Exploration & Exploitation*. 2024. doi: 10.1177/01445987241237152
9. Dinçer H, Yüksel S, Bhatti MIM, Mikhaylov A. EMAS III-based analysis of European eco-management for energy efficiency investments. *Journal of Applied Accounting Research*. 2023. doi: 10.1108/JAAR-08-2022-0216
10. Yüksel S, Dincer H, Mikhaylov A. Analysis of market environment for smart grid technology investments via facial action coding system-enhanced hybrid decision-making model. *International Journal of Innovation Science*. 2024. doi: 10.1108/IJIS-08-2023-0191
11. Aysan AF, Yüksel S, Eti S, et al. A unified theory of acceptance and use of technology and fuzzy artificial intelligence model for electric vehicle demand analysis. *Decision Analytics Journal*. 2024, 11: 100455. doi: 10.1016/j.dajour.2024.100455

Article

Planned versus instinctive behaviour: The connection between personality and food waste

Mann Stefan

Socioeconomics, Agroscope, Ettenhausen 8356, Switzerland; stefan.mann@agroscope.admin.ch

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Abstract: Personality may influence food waste through planned as well as instinctive behaviour. Considerable attention has been devoted to planned behaviour because instincts are difficult to measure using attitudes, behaviours, and intentions. Our study intends to include the instinctive side of behaviour. We used a survey of 339 Swiss households regarding the amount of food waste generated to explore the pathways of how personality influences food waste behaviour. A regression analysis showed that agreeableness and conscientiousness are negative predictors of the amount of food waste. However, the different behaviour of conscientious consumers can be explained by an intermediate variable, whereas the different behaviour of agreeable people can't. This lack of link can be due either to missing suitable intermediate variables or to the role of instinctive behaviour.

Keywords: personality; food waste; Switzerland; instincts; behaviour; survey

1. Introduction

The mere waste of food products has been shown to be one of the main sources of inefficiency in the global food system [1]. This insight has provoked a large body of research, as recently summarised by Boulet et al. [2]. Scientists from all continents are engaging in considerable empirical efforts to understand why an increasing share of people's food purchases are landing in the trash.

Few social-psychological frameworks have gained as much attention as Ajzen's [3] theory of planned behaviour. Food waste research is no exception in this respect. Rivero et al. [4], for example, show how food waste habits indirectly affect future intentions through the mediation of attitude and perceived behavioural control. Graham-Rowe et al. [5] claim that an extended model of planned behaviour that includes attitudes, subjective norms, perceived behavioural control, self-identity, and anticipated regret explains 64% of the variation in the intention to reduce food waste. However, the same authors had to concede that the same variables only explain 5% of the actual success in reducing food waste.

This study uses the construct of personality to argue that instinctive behaviour may be as powerful a predictor of unwanted social behaviour like the generation of food waste, as planned behaviour is. Its objective is to demonstrate the different pathways by which our personalities may impact food waste behaviour, going beyond past studies that have shown connections between personality and food waste intentions.

Accordingly, Section 2 presents a draft of the theoretical framework of this study and incorporates this framework into food waste. Section 3 describes the empirical method of a survey among Swiss food consumers. Sections 4 and 5 present the results and discussion, respectively. Finally, Section 6 presents the conclusions.

2. Literature review and theoretical framework

The notion that personality influences behaviour is not new and has been shown, for example, in the case of different styles of supervision [6], for procrastination [7], and for mobility behaviour [8]. Closest to the issue of food waste came a study by Hakulinen and Johela [9], who showed how different personality profiles differed in alcohol consumption and diet preference.

Figures 1 and 2 are simple causal models in which the rounded rectangles represent the factors that are causally connected by arrows [10]. **Figure 1** describes the hypothesised framework that may be new in its entity but not its components. Its basic presumption is that personality influences behaviour, something that has been repeatedly confirmed by social psychologists [11–14].

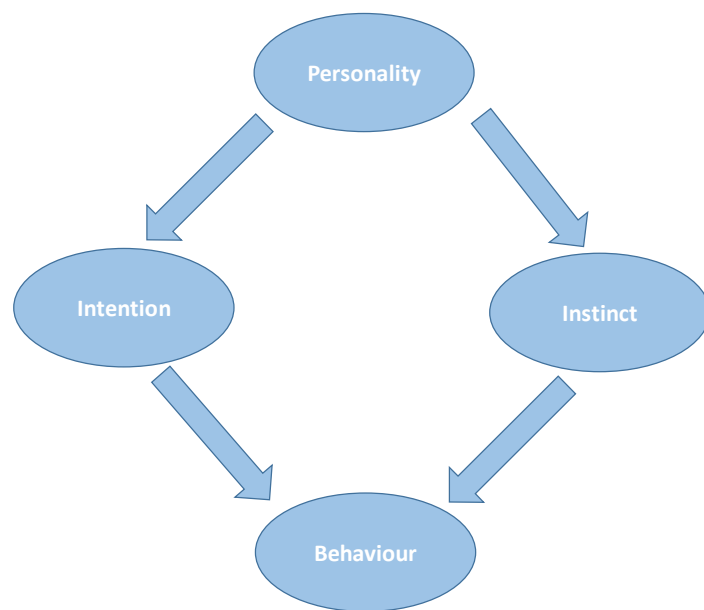


Figure 1. Hypothesising the link between personality and behaviour.

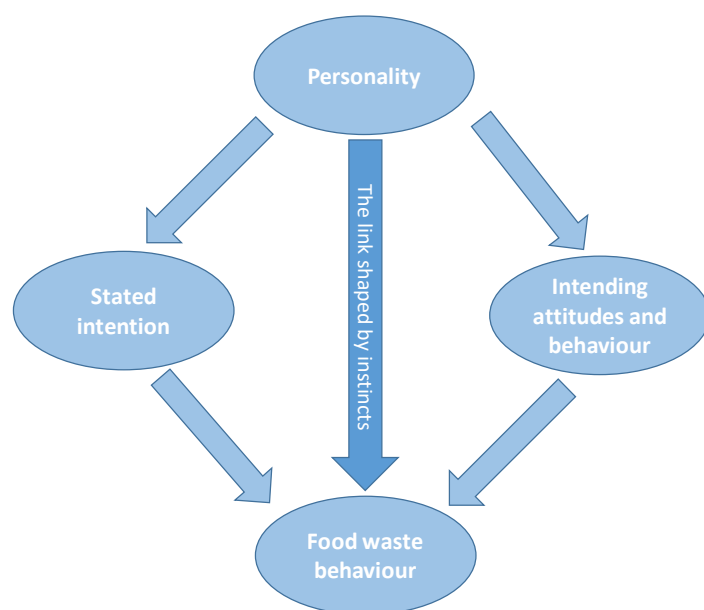


Figure 2. Model of the link between personality and food waste behaviour.

The best-known part of the interactions suggested in **Figure 1** is the link between intentions and behaviour as developed by Ajzen [15] and explored by numerous social scientists (for a review, see Bosnjak et al. [16]). However, while Ajzen considers attitudes and other factors that influence intentions, the model in **Figure 1** suggests a link between personality and intentions.

Whereas Hardison [17] uses a narrative to explore how humans developed their personalities through a transformation from instinct-based animals, other authors show the more complex interplay between instincts and the conceptualisation of personality [18–20]. In the context of this research, considering personality as a factor that shapes instincts is certainly oversimplistic. However, **Figure 1** should be understood in the way that personality has become a concept that could be operationalized and from which conclusions about a person's likely instincts can be drawn.

Burt [21] defines instincts as innate, inherited tendencies; Winston [22] defines them as 'that part of our behaviour that is not learned,' and Faye [23] as congenital reactions to sensory information. These definitions summarized the difficult connection in human behaviour between intentions and immediate learning. They also justify the establishment of this link in the model below. Although the influence of instincts on behaviour is often regarded with scepticism [24], few would deny its existence.

Several authors have mentioned personality as a potential contributor to the amount of food waste in households [25–27]. This study builds on a contribution by Jamaludin et al. [28], who used the Big Five concept of personality [29] to show how different personalities impact the intention, to reduce food waste. In their study, extraversion and agreeableness had a significant influence on the intention to reduce food waste in the future. However, as illustrated in **Figure 1**, this relationship is one of the four arrows depicted in the theoretical framework, that is, from personality to intention. This part has been demonstrated by Jamaludin et al.'s contribution to food waste using a sample group of young Malaysians after the strong link between personality and intentions has been verified in numerous other realms [30,31].

However, it is no coincidence that this past study has focused on the link between personality and intentions as both constructs are relatively easy to measure through questionnaires. The model in **Figure 1** requires further investigation to establish the relationship between instincts and actual behaviour, a true research gap to date that this study intends to fill.

This is an ambitious and perhaps even overambitious task, as the measurement of human instincts is between difficult and impossible. Based on the work by Winston as cited above, Galily [32] emphasizes the "automatic responses" of bodies driven by patterns that have developed over many generations, a definition that serves well for our purposes. Scholars often decide to use latent variables to estimate the prevalence of instincts [33,34], as instincts are strongly interwoven with the subconscious [35]. Particularly in quantitative settings, it is unrealistic to unveil respondents' instincts in a direct, meaningful way within a survey. However, determining the latent forces that drive behaviours and defining them as instinctive may be helpful. If behaviours are not explained by attitudes and intentions, then instincts are likely the invisible variable that drives behavioural patterns.

These results are depicted in the mental model in **Figure 2**. It suggests that certain

relationships between personality and food waste behaviour can be explained by intentions and attitudes and that there are others that cannot. Therefore, the intention to reduce food waste is a part of the intermediate variables. However, behavioural patterns that demonstrate this intention may also play a role, such as checking the fridge before shopping. The intending attitudes depicted in **Figure 2**, for example, towards food leftovers, may also be influenced by personality and have an impact on the amount of food waste. There will always be an interplay between personality and food waste behaviour that does not work via cognitive intermediates but is directly steered via instinctive behavioural patterns.

3. Method

A survey of the main shoppers in the household was designed to test the theoretical model developed above, which includes items on personality, food waste intentions, food waste behaviour and attitudes. After a detailed pre-testing phase, 1600 German, French, or Italian-language questionnaires were distributed to all parts of Switzerland in letterboxes in April 2022. The questionnaire was structured in four parts: It started with a record of actual food waste behaviour, then proceeded to attitudinal and behavioural questions around food waste, applied questions about personality and ended with sociodemographic questions.

A total of 339 responses were returned, resulting in a response rate of 21%. As the questionnaire was distributed on paper only, the age of the average respondent, 53 years, was above the average age of Swiss inhabitants, 42 years. 219 respondents (64%) classified themselves as female, 113 (33%) as male, 2 as other and 5 did not answer the question.

This study also used the Big Five personality concept [29], an influential framework that distinguishes between extroverted, neurotic, agreeable, open and conscientious people, to increase comparability with Jamaludin et al. [28]. This widely accepted framework allows a broad classification of personalities; in the German language, ten questions allow for a fair classification into the five personality categories [36], as every question depicts either one personality profile or the opposite of it. The ten questions were included in the questionnaire, and the respondents' personality profiles were calculated by subtracting the scores of the two questions for each profile.

Many studies prefer to ask for food waste intentions [37–39] because the actual amount of food thrown away is difficult to measure. This approach was not sufficient for our study. Therefore, consumers were asked about the percentage of their purchases from six groups of foods (vegetables, fruit, bread and pastry, dairy, meat/fish and others) that they would often throw away. For 0%, they received a score of 0; 1 for responses between 1% and 10%; and a maximum score of 5 for responses with more than 40% in a category. Therefore, a maximum score of 30 is given if the household throws away more than 40% of each of the six categories.

The responses were analysed in two steps. First, we explored the direct relationship between personality and the food waste index using the control variables displayed in **Table 1**. As control variables, we did not use variables previously found to be of no significance (such as religion according to Qian et al. [40]), but restricted the range of variables to certain variables that had been repeatedly shown to be of

importance for the amount of food waste:

Table 1. Descriptive statistics.

Variable	Explanation	Measurement	Mean	Minimum	Maximum
Dependent variable					
Index	Self-declared level of food waste	Rating between 0 (zero food waste) and 5 (>40% food waste) for six food categories	2.73	0	29
Intermediate variables					
Fridge	‘I check the fridge before shopping’.	0 = never; 1= rarely; 2 = sometimes; 3 = often; 4 = always	3.30	0	4
Leftovers	‘If stored appropriately, leftovers can still be consumed later’.	From 1 (totally disagree) to 5 (totally agree)	4.73	2	5
Warmup	‘I heat leftovers, if available’.	From 1 (totally disagree) to 5 (totally agree)	4.71	1	5
Clearplate	‘My parents found it important that I clear my plate’.	From 1 (totally disagree) to 5 (totally agree)	4.12	1	5
Best	‘I do my best to prevent food waste’.	From 1 (totally disagree) to 5 (totally agree)	4.71	1	5
Personality variables					
Extraversion	Classifications according to Rammstedt et al. [36]	From −4 to 4	−0.91	−4	4
Agreeableness			0.79	−4	4
Conscientiousness			1.86	−3	4
Neuroticism			−0.69	−4	4
Openness			1.38	−4	4
Control variables					
Age	Respondents’ age	Years	52.69	16	92
Income	Respondents’ income group	<3000 <i>Fr.</i> = 0; 3000–5000 <i>Fr.</i> = 1; 5000–8000 <i>Fr.</i> = 2; 8000–11,000 <i>Fr.</i> = 3; >11,000 <i>Fr.</i> = 4	2.20	0	4
Education	Respondents’ educational level	1 = obligatory school; 2 = basic professional training; 3 = high school; 4 = higher professional training; 5 = university	3.38	1	5

All statistical analyses were carried out with Stata 17, using the reg, oprobit and sem functions.

- Many studies show that young people tend to cause more food waste than older people [41,42].
- Other studies also suggest a positive link between household income and the amount of food waste [43–45].
- The connection between educational level and the amount of food wasted is less conclusive but often significant [46–48].

The correlations between the variables were checked and found not to be a problem. Between the Big 5, for example, the maximum correlation was -0.22 (between conscientiousness and extraversion). We used two different functional forms for this regression as the dependent variable ranging between 0 and 30 allows ordered probit analysis and ordinary least squares. To check for robustness, both options were applied. It was also calculated with the same explaining variables of how personality impacted food waste for the main categories of food recorded (vegetables, fruits, meat, bread, and milk), using OLS.

Second, we constructed a structural equation model to identify behavioural and attitudinal variables that link the personality profiles to food waste behaviour. This step is intended to show the degree to which the relationship between personality and food waste is “planned” through different behavioural patterns. The rich literature on the driving factors of food waste allows for the use of items that significantly influence the amount of food waste:

- The lack of planning and excessive purchases have been identified as the main causes of consumption-based food waste [49]. People who check the fridge before shopping tend to cause less food waste [50,51].
- The handling of leftovers has proven to be crucial to avoiding food waste [52–54]. Therefore, this factor is included by one behavioural and one attitudinal variable.
- Education to clear the plate, i.e., parental influence, also has an impact on food waste behaviour [55,56].
- Finally, the intention to reduce food waste is part of the theoretical model and therefore has to be operationalised.

This attempt to show the “planned” component of food waste behaviour can, of course, suffer from the omission of any aspects that would be important behavioural aspects for reducing food waste. Any inability to explain the relationship between personality and food waste through behavioural variables can therefore have two reasons: The relation can be of a purely instinctive nature, or the behavioural link has not been identified. And vice versa, if behavioural differences can be found, instincts may still play a role as well.

Three categorical variables were assumed to be metrics in the analysis of the data. This concerned income classes, as respondents are more reluctant to provide their exact monthly household income [57] than to group themselves into classes, and it concerned education, where no better options exist. In addition, the behaviour regarding checking the fridge was also put into categories that could be understood as metrics. This choice appeared more precise than working with a traditional Likert scale.

4. Results

Table 2 displays the two equations that explain the index derived from the respondents’ statements about the share of food they throw away. Due to some missing values, the results excluded 14 of the 339 responses. Although the significance of “conscientiousness” is slightly lower if you interpret the food waste index as a continuous variable, the match between the two functional forms is considerable. The results reveal that two of the five personality profiles contribute to avoiding food waste. Agreeable and conscientious respondents tend to avoid food loss, with conscientious respondents perhaps having a slightly weaker tendency. The other three personality profiles do not have a significant impact on the amount of food waste.

Table 2. Results of the analyses of the food waste index.

Variable	Ordered probit	OLS
Extraversion	0.04 (1.30)	0.09 (1.33)
Agreeableness	−0.08* (−2.21)	−0.16* (−2.07)
Conscientiousness	−0.08* (−2.10)	−0.14 [°] (−1.80)
Neuroticism	0.01 (0.32)	0.01 (0.17)
Openness	−0.03 (−1.02)	−0.02 (−0.29)
Age	−0.02*** (−5.29)	−0.04*** (−4.71)
Income	0.15*** (2.93)	0.27** (2.56)
Education	0.09 [°] (1.77)	0.20 [°] (1.92)
Constant	−	3.79*** (5.44)
R ²	−	0.20
n	325	325

Note: *, **, *** and [°] denote $p < 0.05$, $p < 0.01$, $p < 0.001$ and $p < 0.1$, respectively. The table displays regression coefficients; z-values and t-values are placed in parentheses.

The three control variables largely played the role they were supposed to play. The results confirm that both higher income and younger age strongly contribute to the generation of food waste. They also show that in Switzerland, consumers with a higher educational level are less reluctant to throw away food than those with a lower education.

Table 3 indicates differences between different food products in a comprehensive way. The better performance of conscientious and agreeable consumers can largely be attributed to bread and milk. It can also be seen that extroverted consumers have an issue with waste when it comes to animal products.

Table 3. Food types thrown away more or less by different personality profiles.

Variable	Vegetables	Fruits	Meat	Bread	Milk
Extraversion			+		+
Agreeableness				(-)	-
Conscientiousness				-	
Neuroticism					
Openness					

+: Significant positive coefficient ($p < 0.05$); -: Significant negative coefficient ($p < 0.05$); (-): Negative coefficient ($p < 0.1$).

Figure 3 displays the second stage of our analysis, that is, the structural equation model that should explain the link between the personality profiles and the amount of food waste. The log-likelihood of this model was -6554 , with a probability of error of 0.000 . As only significant arrows are shown, it can be seen that this task is partly accomplished. Only three of the five intermediate variables link to a personality profile, and another two to the amount of food waste. Only the habit of heating leftovers can be explained by one of the personality profiles and thus also influences the amount of food waste.

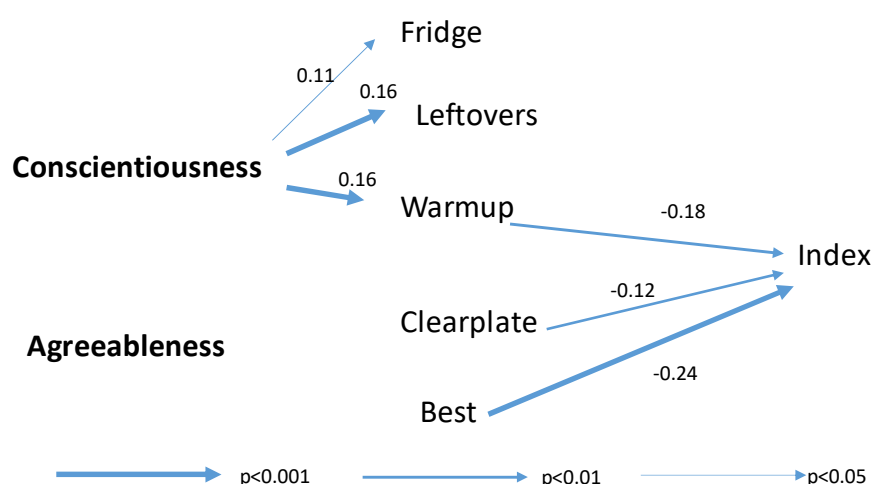


Figure 3. Results of the structural equation modelling (the numbers describe correlation coefficients).

More importantly, no significant relationship between any of the five intermediate variables and agreeableness could be established. **Table 2** indicates that the link between agreeableness and the amount of food waste may even be stronger

than that between conscientiousness and the amount of food waste. However, agreeableness influences food waste, not via the intentions and attitudes used in the survey.

5. Discussion

It is worthwhile to take a second look at the results of the regression analysis. As educational levels tend to rise over time, incomes tend to rise as well, and as the older generation dies away, there is little reason to be optimistic about the amount of food thrown away in the future. Young consumers throw much more food away than old consumers and wealthy ones throw more than poor ones. And if education, as could be shown, has the effect that more, not less, food is thrown away, it is fair to argue that traditional educative organizations like schools and universities neglect the significance of food waste in their curricula. Apparently, it needs new approaches to tackle food waste, and these new approaches may include a differentiation between different personality types.

The regression analysis also indicated that two personality types stood out with respect to food waste. When targeting problematic personality types, open, neurotic and, in particular, extroverted individuals have the largest potential to reduce the amount of food thrown away.

In the scientific literature, it is usually not regarded as an achievement if something cannot be explained in a statistically significant way. However, this phenomenon occurred when trying to undermine the statistically significant link between agreeableness and the amount of food waste through intermediary variables. Thus, briefly exploring the literature on agreeableness is helpful in solving the puzzle.

Graziano and Tobin [58] summarized that ‘agreeableness did not initially receive systematic empirical research because of deductive top-down theorizing about its link to biology’. This body of literature includes, for example, lectures by Dambeck [59], who describes agreeableness as an instinctive behaviour towards personal well-being, as well as a paper by McCormick [60], who also links feelings of agreeableness to human instincts.

A large part of the contemporary literature on agreeableness centres on prosocial motivations [61] and interpersonal relationships [62]. However, Tackett et al. [63] emphasise that agreeableness also intersects with self-regulation and self-discipline.

All this serves well to make the relationship between agreeableness and the avoidance of food waste more palatable. Agreeable individuals will (instinctively) strive to valorise their food, whether to please their partner who has cooked the meal or protect the environment, where wasted food presents a challenge to efficient resource use.

The avoidance of food waste by conscientious individuals works in a different way, making it more accessible to social scientists. As Roberts et al. [64] describe orderliness and industriousness as the main traits of conscientiousness, these traits help to generate cognitive constructs that contribute to being modest when shopping and well-structured when preparing meals.

The fact that instincts can hardly be investigated by objective, scientific methods should not seduce us to over-rationalize human behaviour. The two possible different routes to avoid food waste, which could be distinguished through the construct of

different personality traits are a case in point to acknowledge the importance of not only planned but also unplanned behaviour.

6. Conclusions

The survey on food waste generated in Switzerland has confirmed several connections that have been observed in other parts of the world thus far. The young lad, who does not care about leftovers or the contents of his fridge, will waste more than the poor pensioner who has been taught by his parents to clear his plate. It also confirms results from Malaysia, where agreeable individuals have been shown to waste less food than others.

However, the study's main contribution is the analysis of the influence of socio-psychological mechanisms of personality on the amount of food waste generated. Planned behaviour is a good predictor of why conscientious individuals waste less food than others. They have the attitude of using leftovers for another meal, as indicated by the variable "leftovers" and act accordingly, as indicated by the variable "warmup". For individuals who are considered agreeable, the connection is different. Their attitudes and intentions toward food waste do not stand out in comparison with their peers, though their behaviour does. Their interaction with the world demonstrates fewer cognitive ways to reduce food waste, a pattern that may be due to intermediate behavioural variables not identified by the authors or that can be best characterised by the term 'instinctive'. This difference should be considered when working on campaigns to reduce food waste. It is likely that communication that dwells on certain behavioural patterns works better for conscientious individuals, whereas more effective campaigns fare better for individuals classified as "agreeable".

The most severe limitation of this study is, of course, that it treats these 'instincts' as a latent variable that is hypothesised if other relationships are not significant. Regarding the important questions of how instincts shape humans' behaviour as well as the habit of throwing away food, improved operationalisations should be used for future research. This should solve the question of whether other intermediate variables can be identified that moderate the link between "agreeableness" and food waste behaviour.

Another imperative for future research is certainly to identify strategies to utilize the results of this study for the reduction of food waste. Campaigns with that purpose may primarily refer to affective states or target specific behavioural patterns. It will be useful to find out which personality profile is targeted in which way to be most effective.

Conflict of interest: The author declares no conflict of interest.

References

1. Muller A, Schader C, El-Hage Scialabba N, et al. Strategies for feeding the world more sustainably with organic agriculture. *Nature Communications*. 2017, 8(1). doi: 10.1038/s41467-017-01410-w
2. Boulet M, Hoek AC, Raven R. Towards a multi-level framework of household food waste and consumer behaviour: Untangling spaghetti soup. *Appetite*. 2021, 156: 104856. doi: 10.1016/j.appet.2020.104856
3. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. 1991, 50(2): 179-211. doi: 10.1016/0749-5978(91)90020-T

4. Rivero R, Amato M, La Barbera F. The effect of food waste habit on future intention to reduce household food waste. *Quality-Access to Success*. 2017, 18(S2): 369-375.
5. Graham-Rowe E, Jessop DC, Sparks P. Predicting household food waste reduction using an extended theory of planned behaviour. *Resources, Conservation and Recycling*. 2015, 101: 194-202. doi: 10.1016/j.resconrec.2015.05.020
6. Tahira B, Saif N, Haroon M, et al. Relationship between big five personality model and abusive supervision. *Abasyn Journal of Social Sciences*. 2019, 12(2). doi: 10.34091/ajss.12.2.05
7. Dominguez-Lara S, Prada-Chapoñan R, Moreta-Herrera R. Gender differences in the influence of personality on academic procrastination in Peruvian university students (Spanish). *Acta Colombiana de Psicología*. 2019, 22(2): 125-136. doi: 10.14718/acp.2019.22.2.7
8. Roos JM, Sprei F, Holmberg U. Traits and Transports: The Effects of Personality on the Choice of Urban Transport Modes. *Applied Sciences*. 2022, 12(3): 1467. doi: 10.3390/app12031467
9. Hakulinen C, Jokela M. Personality as determinant of smoking, alcohol consumption, physical activity, and diet preferences. In: Johansen C (editor). *Personality and Disease: Scientific Proof Vs. Wishful Thinking*. Elsevier Inc; 2018. pp. 33-48. doi: 10.1016/b978-0-12-805300-3.00003-7
10. Elwert F. Graphical causal models. In: Morgan SL (editor). *Handbook of Causal Analysis for Social Research*. Springer; 2013. doi: 10.1007/978-94-007-6094-3_13
11. Cooper CA, Golden L, Socha A. The Big Five personality factors and mass politics. *Journal of Applied Social Psychology*. 2013, 43(1): 68-82.
12. Cooper ML, Agocha VB, Sheldon MS. A Motivational Perspective on Risky Behaviors: The Role of Personality and Affect Regulatory Processes. *Journal of Personality*. 2000, 68(6): 1059-1088. doi: 10.1111/1467-6494.00126
13. Andersen JA. Leadership, personality and effectiveness. *The Journal of Socio-Economics*. 2006, 35(6): 1078-1091. doi: 10.1016/j.soc.2005.11.066
14. Van der Schiff KA. *Personality-Based Surveillance Model for Facebook Apps*. Rhodes University Press; 2019.
15. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. 1991, 50(2): 179-211.
16. Bosnjak M, Ajzen I, Schmidt P. The theory of planned behavior: Selected recent advances and applications. *Europe's Journal of Psychology*. 2020, 16(3): 352-356. doi: 10.5964/ejop.v16i3.3107
17. Hardison D. *From Instinct to Identity*. Routledge; 2009.
18. De Raad B, Doodema-Winsemius M. Instincts and personality. *Personality and Individual Differences*. 1999, 27(2): 293-305.
19. Piechurska-Kuciel E. Personality: Definitions, approaches, and theories. In: Piechurska-Kuciel E (editor). *The Big Five in SLA*. Springer; 2020.
20. Sun R, Wilson N. Roles of implicit processes: instinct, intuition, and personality. *Mind & Society*. 2013, 13(1): 109-134. doi: 10.1007/s11299-013-0134-4
21. Burt C. Is the doctrine of instincts dead? A symposium. *British Journal of Educational Psychology*. 1942, 12(1): 1-9. doi: 10.1111/j.2044-8279.1943.tb02714.x
22. Winston R. *Human Instinct*. Random House; 2011.
23. Faye J. *The Biological and Social Dimensions of Human Knowledge*. Springer Nature Switzerland; 2023. doi: 10.1007/978-3-031-39137-8
24. Pirson M. A Humanistic Perspective for Management Theory: Protecting Dignity and Promoting Well-Being. *Journal of Business Ethics*. 2017, 159(1): 39-57. doi: 10.1007/s10551-017-3755-4
25. Abdelradi F. Food waste behaviour at the household level: A conceptual framework. *Waste Management*. 2018, 71: 485-493. doi: 10.1016/j.wasman.2017.10.001
26. Altintzoglou T, Honkanen P, Whitaker RD. Influence of the involvement in food waste reduction on attitudes towards sustainable products containing seafood by-products. *Journal of Cleaner Production*. 2021, 285: 125487. doi: 10.1016/j.jclepro.2020.125487
27. Kutlu MB. A Trait-Based Consumer Segmentation for Food Waste Reduction Campaigns. *Social Marketing Quarterly*. 2022, 28(2): 130-146. doi: 10.1177/15245004221097752
28. Jamaludin H, Mohamed B, Noorashid NA. Food waste motivational factors: The theory of planned behavior and the role of Big-Five personality traits on Malaysians Generation Z. *Global Business and Management Research*. 2020, 12(4): 73-89.
29. Roccas S, Sagiv L, Schwartz SH, et al. The Big Five Personality Factors and Personal Values. *Personality and Social Psychology Bulletin*. 2002, 28(6): 789-801. doi: 10.1177/0146167202289008

30. Lissitsa S, Kol O. Four generational cohorts and hedonic m-shopping: association between personality traits and purchase intention. *Electronic Commerce Research*. 2019, 21(2): 545-570. doi: 10.1007/s10660-019-09381-4
31. Zhao H, Seibert SE, Lumpkin GT. The relationship of personality to entrepreneurial intentions and performance: A meta-analytic review. *Journal of Management*. 2009, 36(2). doi: 10.1177/0149206309335187
32. Galily D. An Evolutionary Approach to the Research of Speculative Historiosophy and Its Possible Influences on the Research of the Social Sciences and Humanities. *Open Journal for Anthropological Studies*. 2022, 6(1): 11-14. doi: 10.32591/coas.ojas.0601.02011g
33. Armansyah RF. Herd instinct biases, emotional bias, and information processing biases in investment decisions. *Jurnal Manajemen dan Kewirausahaan*. 2022, 24(2): 105-117. doi: 10.9744/jmk.24.2.105-117
34. Ball KH. *So Powerful a Form: Rethinking Girl's Sexuality*. Emory University Press; 2014.
35. Pocuca N. *The Legacy of Carl Gustav Jung: Popular Distortions and Suppressions of Analytical Psychology* [PhD thesis]. Filozofski fakultet u Zagrebu; 2019.
36. Rammstedt B, Kemper CJ, Klein MC, et al. A short scale to measure the five dimensions of personality: Big-five-inventory-10 BFI-10 (German). Available online: <https://nbn-resolving.org/urn:nbn:de:0168-ssoar-312133> (accessed on 2 January 2024).
37. Elhoushy S, Jang S (Shawn). Religiosity and food waste reduction intentions: A conceptual model. *International Journal of Consumer Studies*. 2020, 45(2): 287-302. doi: 10.1111/ijcs.12624
38. Elshaer I, Sobaih AEE, Alyahya M, et al. The Impact of Religiosity and Food Consumption Culture on Food Waste Intention in Saudi Arabia. *Sustainability*. 2021, 13(11): 6473. doi: 10.3390/su13116473
39. Lin B, Guan C. Determinants of household food waste reduction intention in China: The role of perceived government control. *Journal of Environmental Management*. 2021, 299: 113577. doi: 10.1016/j.jenvman.2021.113577
40. Qian L, Li F, Cao B, et al. Determinants of food waste generation in Chinese university canteens: Evidence from 9192 university students. *Resources, Conservation and Recycling*. 2021, 167: 105410. doi: 10.1016/j.resconrec.2021.105410
41. Hebrok M, Boks C. Household food waste: Drivers and potential intervention points for design – An extensive review. *Journal of Cleaner Production*. 2017, 151: 380-392. doi: 10.1016/j.jclepro.2017.03.069
42. Janssens K, Lambrechts W, van Osch A, Semeijn J. How Consumer Behavior in Daily Food Provisioning Affects Food Waste at Household Level in the Netherlands. *Foods*. 2019, 8(10): 428. doi: 10.3390/foods8100428
43. Baker D, Fear J, Denniss R. *What a waste: an analysis of household expenditure on food*. The Australia Institute; 2009.
44. Mattar L, Abiad MG, Chalak A, et al. Attitudes and behaviors shaping household food waste generation: Lessons from Lebanon. *Journal of Cleaner Production*. 2018, 198: 1219-1223. doi: 10.1016/j.jclepro.2018.07.085
45. Ilakovac B, Voca N, Pezo L, et al. Quantification and determination of household food waste and its relation to sociodemographic characteristics in Croatia. *Waste Management*. 2020, 102: 231-240. doi: 10.1016/j.wasman.2019.10.042
46. Di Talia E, Simeone M, Scarpato D. Consumer behaviour types in household food waste. *Journal of Cleaner Production*. 2019, 214: 166-172. doi: 10.1016/j.jclepro.2018.12.216
47. Biliska B, Tomaszewska M, Kolożyn-Krajewska D. Analysis of the Behaviors of Polish Consumers in Relation to Food Waste. *Sustainability*. 2019, 12(1): 304. doi: 10.3390/su12010304
48. Herzberg R, Schmidt TG, Schneider F. Characteristics and Determinants of Domestic Food Waste: A Representative Diary Study across Germany. *Sustainability*. 2020, 12(11): 4702. doi: 10.3390/su12114702
49. dos Santos JIAS, da Silveira DS, da Costa MF, et al. Consumer behaviour in relation to food waste: a systematic literature review. *British Food Journal*. 2022, 124(12): 4420-4439. doi: 10.1108/bfj-09-2021-1075
50. Borg K, Boulet M, Karunasena G, et al. Segmenting households based on food waste behaviours and waste audit outcomes: Introducing Over Providers, Under Planners and Considerate Planners. *Journal of Cleaner Production*. 2022, 351: 131589. doi: 10.1016/j.jclepro.2022.131589
51. Ghinea C, Ghiuta OA. Household food waste generation: young consumers behaviour, habits and attitudes. *International Journal of Environmental Science and Technology*. 2018, 16(5): 2185-2200. doi: 10.1007/s13762-018-1853-1
52. Cronje N, van der Merwe I, Müller IM. Household food waste: A case study in Kimberley, South Africa. *Journal of Consumer Sciences*. 2018, 46: 1-9.
53. Stancu V, Haugaard P, Lähteenmäki L. Determinants of consumer food waste behaviour: Two routes to food waste. *Appetite*. 2016, 96: 7-17. doi: 10.1016/j.appet.2015.08.025
54. Ananda J, Karunasena GG, Mitsis A, et al. Analysing behavioural and socio-demographic factors and practices influencing Australian household food waste. *Journal of Cleaner Production*. 2021, 306: 127280. doi: 10.1016/j.jclepro.2021.127280

55. Doron N. A clear plate means a clear conscience. In: Doron N (editor). *Revaluing food*, Fabian Society; 2012.
56. Robinson E, Hardman CA. Empty plates and larger waists: a cross-sectional study of factors associated with plate clearing habits and body weight. *European Journal of Clinical Nutrition*. 2015, 70(6): 750-752. doi: 10.1038/ejcn.2015.218
57. Fink A. *How to Conduct Surveys—A Step by Step Guide*. Thousand Oaks SAGE; 2015.
58. Graziano WG, Tobin RM. Agreeableness in MR Leary, RH Hoyle: *Handbook of Individual Differences in Social Behavior*. The Guilford Press; 2009.
59. Dambeck JH. Lectures on aesthetics (German). In: Joseph A (editor). *Enders*; 1822.
60. McCormick TC. A point of view on instincts in social psychology. *The Journal of Abnormal and Social Psychology*. 1931, 26(1): 102-105. doi: 10.1037/h0074848
61. Graziano WG, Habashi MM, Sheese BE, et al. Agreeableness, empathy, and helping: A person $\times$ situation perspective. *Journal of Personality and Social Psychology*. 2007, 93(4): 583-599. doi: 10.1037/0022-3514.93.4.583
62. Wang JM, Hartl AC, Laursen B, et al. The high costs of low agreeableness: Low agreeableness exacerbates interpersonal consequences of rejection sensitivity in U.S. and Chinese adolescents. *Journal of Research in Personality*. 2017, 67: 36-43. doi: 10.1016/j.jrp.2016.02.005
63. Tackett JL, Hernandez MM, Eisenberg N. Agreeableness. In: Adams DP, Shiner RL, Tackett JL (editor). *Handbook of Personality Development*. The Guilford Press; 2019.
64. Roberts BW, Lejuez C, Krueger RF, et al. What is conscientiousness and how can it be assessed? *Developmental Psychology*. 2014, 50(5): 1315-1330. doi: 10.1037/a0031109

Article

Evaluating the ecological consequences of heavy metal contamination in soil induced by spent engine oil and palm oil mill effluents for sustainable development

Tobechukwu Ebele Okeke^{1,2,*}, Sylvanus Chima Ewuim², Cosmas Augustus Uhwo³, Benjamin Uzonna Ononye², Chidi Emmanuel Akunne², Kasarachi Patricia Okafor²

¹ Department of Biology, Alex Ekwueme University, Ndufu-Alike Ikwo 482131, Nigeria

² Department of Zoology, Nnamdi Azikiwe University, Awka 420110, Nigeria

³ Department of Applied Biology, Ebonyi State University, Abakaliki 481101, Nigeria

* **Corresponding author:** Tobechukwu Ebele Okeke, okekete15002f@gmail.com

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Abstract: This study assessed the ecological consequences of heavy metal contamination in soil induced by spent engine oil (SEO) and palm oil mill effluents (POME) in Ebonyi State, Nigeria. Concentrations of zinc, nickel, mercury, manganese, lead, iron, copper, chromium, and cadmium were analyzed across contaminated and uncontaminated sites. The research, conducted at Ebonyi State University's Presco Campus, employed rigorous sampling and analytical methods. Results revealed that soil contaminated with spent engine oil effluent exhibited elevated mean concentrations of zinc, nickel, manganese, lead, iron, copper, chromium, and cadmium compared to the palm oil mill effluent and control sites. Conversely, mercury concentrations were higher in soil contaminated with palm oil mill effluent. Comparative analyses highlighted unique dynamics, such as lead concentrations being highest at the control site, challenging general trends observed for other metals. Importantly, none of the mean concentrations exceeded the WHO acceptable limits at the time of the study, indicating compliance with internationally recognized safety thresholds. The findings underscore the need for tailored environmental management strategies, considering specific contaminants associated with each effluent type. Continuous monitoring is crucial to ensure sustained adherence to safety standards and prevent potential future exceedances. This study contributes a valuable understanding of the nuanced ecological impact of industrial effluents on soil quality in Nigeria, emphasizing the importance of sustainable practices for environmental protection.

Keywords: ecological consequences; heavy metal; contamination; soil; spent engine oil; palm oil mill; effluents; sustainable development

1. Introduction

In the pursuit of industrialization and economic growth, developing nations often grapple with the environmental consequences of industrial activities. One significant environmental challenge is the contamination of soil with heavy metals, a consequence of various industrial effluents. Heavy metal contamination poses a severe threat to ecosystems, public health, and overall sustainable development [1,2]. This study focuses on evaluating the ecological consequences of heavy metal contamination in soil induced by two prevalent industrial effluents—spent engine oil and palm oil mill effluents—in the context of achieving sustainable development goals.

Rapid industrialization, population growth, and increased urbanization have led

to intensified industrial activities, contributing to the release of diverse pollutants into the environment [3,4]. Among these pollutants, heavy metals stand out due to their persistence and potential for bioaccumulation in ecosystems, causing long-term environmental and health concerns. Heavy metals, including zinc (Zn), nickel (Ni), mercury (Hg), manganese (Mn), lead (Pb), iron (Fe), copper (Cu), chromium (Cr), and cadmium (Cd), are often associated with industrial processes and can contaminate soil through various pathways, including direct discharge or accidental spills [5,6]. Of particular concern are spent engine oil and palm oil mill effluents, which are common byproducts of the automotive and agro-industrial sectors, respectively [4,7,8]. These effluents contain a complex mixture of organic and inorganic compounds, including heavy metals, and when not managed properly, can result in widespread environmental contamination. The ecological consequences of heavy metal contamination in soil extend beyond the immediate vicinity of industrial sites, affecting terrestrial and aquatic ecosystems, as well as human populations through the food chain.

Understanding the ecological consequences of heavy metal contamination in soil induced by spent engine oil and palm oil mill effluents is imperative for several reasons. Firstly, heavy metals are non-biodegradable and can persist in the environment for extended periods, leading to cumulative effects on soil quality and ecosystem health. Secondly, the potential for bioaccumulation of heavy metals in plant and animal tissues raises concerns about their entry into the food chain, posing risks to human health. Thirdly, the impact of heavy metal contamination on biodiversity, soil fertility, and overall ecosystem functioning has broader implications for sustainable development [9–12].

Sustainable development, as articulated in the United Nations' Sustainable Development Goals (SDGs), seeks to balance economic growth, social well-being, and environmental protection. Achieving sustainable development requires a comprehensive understanding of the interconnections between industrial activities, environmental health, and societal well-being [13,14]. Therefore, assessing the ecological consequences of heavy metal contamination in soil aligns with the broader goal of fostering sustainable practices in industrial processes [15]. The motivation for undertaking the study is rooted in the critical intersection of industrial activities, environmental sustainability, and human well-being. In the pursuit of economic development, many developing nations, including Nigeria, have witnessed a surge in industrialization, resulting in increased production and utilization of various substances, some of which have adverse environmental consequences.

SEO and POME are two prominent industrial effluents that have raised environmental concerns due to their potential to introduce heavy metals into the soil. These heavy metals, including zinc, nickel, mercury, manganese, lead, iron, copper, chromium, and cadmium, are notorious for their persistence and potential toxicity. The lack of proper waste management practices in industrial processes often leads to the direct discharge of these effluents into the environment, resulting in soil contamination. The motivation for this study is also underscored by the need to comprehend the specific ecological consequences of heavy metal contamination associated with SEO and POME. While prior research has explored the impact of industrial effluents on soil quality [16], a comprehensive investigation focusing on

the intricate dynamics of these two prevalent effluents is notably lacking. This gap in the literature emphasizes the urgency to address the nuanced environmental implications of SEO and POME, especially in the context of achieving sustainable development goals.

Existing literature underscores the gaps that motivate this study. For instance, a study by Ilyas et al. [17] highlighted the general environmental impact of industrial effluents but did not specifically delve into the unique consequences associated with SEO and POME. Similarly, the work of Golia [18] discussed heavy metal contamination in soils but did not provide a detailed analysis of the ecological repercussions specific to these two prevalent effluents. Furthermore, while studies such as those by Long et al. [19] and Pushpanjali et al. [20] have investigated the effects of industrial activities on soil quality, they did not distinctly address the potential variations in heavy metal concentrations induced by SEO and POME. This highlights a critical knowledge gap regarding the specific ecological consequences of these effluents, hindering the development of targeted mitigation strategies.

This study's significance lies in bridging critical knowledge gaps regarding the specific ecological consequences of heavy metal contamination in soil induced by spent engine oil (SEO) and palm oil mill effluents (POME). Existing literature lacks detailed analyses of the unique repercussions associated with these prevalent effluents, hindering the development of targeted mitigation strategies. By evaluating the ecological impact of SEO and POME, this study contributes vital understanding for informed environmental management and sustainable development, addressing a crucial need for understanding and addressing the distinctive challenges posed by these industrial byproducts.

More specifically, the motivation for this study is intricately linked to the broader goal of achieving sustainable development. Sustainable development, as encapsulated in the United Nations' Sustainable Development Goals (SDGs), requires a harmonious balance between economic growth, environmental conservation, and social well-being. Understanding the ecological consequences of heavy metal contamination induced by SEO and POME is crucial for advancing this balance. The potential impacts on soil quality and biodiversity have far-reaching consequences, affecting ecosystem services, agricultural productivity, and human health. By comprehensively evaluating the specific heavy metal concentrations associated with SEO and POME, this study seeks to provide an understanding that can inform sustainable practices in the industrial sector. The aim is to mitigate environmental degradation while fostering economic growth, aligning with SDGs such as responsible consumption and production (Goal 12) and environmental protection (Goal 15).

2. Methods

The study was conducted at Ebonyi State University's Presco Campus in Abakaliki, Nigeria, situated within the Guinea Savannah zone. The region experiences bimodal rainfall, with a mean annual temperature ranging from 29 °C to 30 °C. The undulating terrain features irregular river valleys, ridges, and a dendritic drainage pattern. The study area includes open savannah woodland with a diverse

array of species, including woody trees, shrubs, herbs, palms, climbers, and tall grasses. Two habitats were stratified for insect assessment, employing handheld sweep nets and pitfall traps. A 0.23 km line transect was established at each site, and six transect walks were conducted, each lasting 30 min. Sweep net sampling occurred twice weekly during morning and evening hours along predetermined transects, while 12 pitfall traps were distributed in various habitats. Insects captured were preserved using a wide-mouthed jar containing ethyl acetate. Preservation methods included direct pinning for larger insects and pickling for specimens unable to be pinned. Laboratory identification utilized keys from reputable sources. Descriptive statistics was employed for data analysis.

The inclusion of zinc (Zn), nickel (Ni), mercury (Hg), manganese (Mn), lead (Pb), iron (Fe), copper (Cu), cobalt (Co), chromium (Cr), and cadmium (Cd) in the study is crucial for a comprehensive assessment of ecological consequences. These heavy metals, commonly found in spent engine oil and palm oil mill effluents, pose distinct environmental risks. Zn, Ni, and Cd are known for soil toxicity, while Hg is a potent bio-accumulative neurotoxin. Mn, Pb, and Fe can impact plant growth and human health, and Cu, Co, and Cr exhibit varying degrees of environmental persistence. Studying these metals is essential for understanding the multifaceted ecological impact, facilitating targeted remediation strategies, and ensuring sustainable development in affected areas.

3. Results

Table 1 revealed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for zinc (0.33 ± 0.365 mg/kg) while the palm oil effluent site had the least (0.05 ± 0.061 mg/kg). There was no significant difference in the mean concentration of zinc among the three sites ($P = 0.196$). However, the concentrations of zinc were lower than the WHO-acceptable limit. The result in **Table 1** revealed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for nickel (27.07 ± 25.955 mg/kg) while the control site had the least (3.48 ± 0.556 mg/kg). There was no significant difference in the mean concentration of nickel among the three sites ($P = 0.22$). However, the concentrations of nickel were lower than the WHO acceptable limit.

Table 1. Mean concentration of heavy metals of the contaminated and uncontaminated sites.

Heavy metals	Sites			Reference (WHO) mg/kg	Remark
	POME	SEO	Control		
Zn	$0.05^a \pm 0.061$	$0.33^a \pm 0.365$	$0.08^a \pm 0.077$	300	Satisfactory
Ni	$17.69^a \pm 16.504$	$27.07^a \pm 25.955$	$3.48^a \pm 0.556$	50	Satisfactory
Hg	$0.24^a \pm 0.002$	$0.17^a \pm 0.173$	$0.16^a \pm 0.018$	1.0	Satisfactory
Mn	$1.12^a \pm 1.298$	$3.86^a \pm 4.209$	$2.87^a \pm 2.674$	2000	Satisfactory
Pb	$0.00^a \pm 0.000$	$0.01^a \pm 0.012$	$0.23^b \pm 0.046$	85	Satisfactory
Fe	$0.63^a \pm 0.724$	$2.41^a \pm 2.781$	$0.65^a \pm 0.207$	50,000	Satisfactory
Cu	$0.56^a \pm 0.618$	$3.07^a \pm 3.479$	$0.57^a \pm 0.632$	100	Satisfactory
Co	$0.06^a \pm 0.069$	$0.51^a \pm 0.59$	$0.39^a \pm 0.464$	19	Satisfactory
Cr	$0.10^a \pm 0.114$	$0.25^a \pm 0.046$	$0.24^a \pm 0.11$	100	Satisfactory
Cd	$0.05^a \pm 0.058$	$1.84^a \pm 3.24$	$0.31^a \pm 0.338$	3	Satisfactory

Rows sharing similar superscripts are not significantly different at $p > 0.05$; key: POME = palm oil mill effluent; SEO = spent engine oil; control = uncontaminated site.

Table 1 revealed that soil contaminated with palm oil mill effluent recorded the highest mean concentrations for mercury (0.24 ± 0.002 mg/kg) while the control site had the least (0.16 ± 0.018 mg/kg). There was no significant difference in the mean concentration of mercury among the three sites ($P = 0.49$). However, the concentrations of mercury were lower than the WHO-acceptable limit. The result in **Table 1** revealed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for manganese (3.86 ± 4.209 mg/kg) while the palm oil mill effluent site had the least (1.12 ± 1.298 mg/kg). There was no significant difference in the mean concentration of nickel among the three sites ($P = 0.45$). However, the concentrations of manganese were lower than the WHO-acceptable limit.

The result showed that the soil from the control site recorded the highest mean concentrations for lead (0.23 ± 0.046 mg/kg) while the palm oil mill effluent site had the least (0.00 ± 0.000 mg/kg) (**Table 1**). There was a significant difference in the mean concentration of lead among the three sites ($P = 0.00$). However, the concentrations of lead were lower than the WHO acceptable limit. The result in **Table 1** revealed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for iron (2.41 ± 2.78 mg/kg) while the palm oil mill effluent site had the least (0.63 ± 0.724 mg/kg). There was no significant difference in the mean concentration of iron among the three sites ($P = 0.27$). However, the concentrations of iron were lower than the WHO-acceptable limit.

The result in **Table 1** revealed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for copper (3.07 ± 3.479 mg/kg) while the palm oil mill effluent site had the least (0.56 ± 0.618 mg/kg). There was no significant difference in the mean concentration of iron among the three sites ($P = 0.19$). However, the concentrations of copper were lower than the WHO acceptable limit. **Table 1** also revealed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for copper (0.51 ± 0.591 mg/kg) while the palm oil mill effluent site had the least (0.06 ± 0.069 mg/kg). There was no significant difference in the mean concentration of cobalt among the three sites ($P = 0.36$). However, the concentrations of cobalt were lower than the WHO-acceptable limit.

The result in **Table 1** also showed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for chromium (0.25 ± 0.046 mg/kg) while the palm oil mill effluent site had the least (0.10 ± 0.114 mg/kg). There was no significant difference in the mean concentration of chromium among the three sites ($P = 0.09$). However, the concentrations of chromium were lower than the WHO-acceptable limit. The result in **Table 1** also showed that soil contaminated with spent engine oil effluent recorded the highest mean concentrations for cadmium (1.84 ± 3.24 mg/kg) while the palm oil mill effluent site had the least (0.05 ± 0.058 mg/kg). There was no significant difference in the mean concentration of cadmium among the three sites ($P = 0.39$). However, the concentrations of cadmium were lower than the WHO-acceptable limit.

4. Discussions

The comprehensive analysis of soil contaminants across multiple sites reveals intriguing patterns, providing an understanding of the environmental impact of industrial effluents in Nigeria. The concentration of various heavy metals, including zinc, nickel, mercury, manganese, lead, iron, copper, chromium, and cadmium, was assessed across sites with different effluent types. In terms of zinc concentrations, soil contaminated with spent engine oil effluent exhibited the highest mean values, showcasing the potentially detrimental effects of such contamination. This finding aligns with the work of Peter [16], who similarly highlighted the impact of engine oil effluents on soil quality. In contrast, the palm oil effluent site recorded the least zinc concentrations, suggesting a comparatively lower environmental impact, as emphasized by the findings of Lai et al. [21]. Similar trends were observed for nickel concentrations, with soil contaminated by spent engine oil effluent displaying the highest mean values. Notably, the control site exhibited the least nickel concentrations, indicating the absence of contaminating factors. This aligns with the observations in a related study by Hu et al. [22] and Khademi et al. [23], reinforcing the persistence of nickel in soils impacted by industrial activities.

Mercury concentrations followed a different pattern, with soil contaminated by palm oil mill effluent recording the highest mean values. In contrast, the control site exhibited the least mercury concentrations. This finding is consistent with the work of Isaiah and Blessing [4], who emphasized the role of palm oil mill effluents in elevating mercury levels in soil, posing potential environmental risks. Manganese concentrations displayed a distinct pattern, with soil contaminated by spent engine oil effluent exhibiting the highest mean values. In contrast, the palm oil mill effluent site recorded the least manganese concentrations. This aligns with a related study by Ikhajiagbe et al. [1] and Salam et al. [8], which emphasized the impact of engine oil effluents on soil manganese levels. Lead concentrations portrayed an interesting contrast, with soil from the control site recording the highest mean values and the palm oil mill effluent site having the least. This contradicts the general trend observed for other metals, highlighting the unique dynamics of lead contamination [3,24] further explored lead contamination in soils, emphasizing the importance of understanding site-specific factors influencing metal concentrations.

Iron concentrations exhibited a pattern similar to zinc and nickel, with soil contaminated by spent engine oil effluent displaying the highest mean values. In contrast, the palm oil mill effluent site recorded the least iron concentrations. This consistency across multiple metals underscores the pervasive impact of engine oil effluents on soil quality [7]. Copper concentrations mirrored the trends observed for zinc, nickel, and iron, with soil contaminated by spent engine oil effluent exhibiting the highest mean values. In contrast, the palm oil mill effluent site recorded the least copper concentrations. This aligns with the findings of Oriomah et al. [6], who emphasized the role of engine oil effluents in elevating copper levels in soils.

Chromium concentrations followed a similar pattern, with soil contaminated by spent engine oil effluent displaying the highest mean values. In contrast, the palm oil mill effluent site recorded the least chromium concentrations. This finding is consistent with the observations of Dhal et al. [25], reinforcing the specific impact of

engine oil effluents on soil chromium levels. Cadmium concentrations exhibited a pattern akin to that of other metals, with soil contaminated by spent engine oil effluent displaying the highest mean values. In contrast, the palm oil mill effluent site recorded the least cadmium concentrations. This is in line with the work of Wang et al. [10], who emphasized the potential risks associated with cadmium contamination in soils impacted by industrial activities.

Despite the variations in metal concentrations across sites, it is noteworthy that none of the mean concentrations exceeded the WHO-acceptable limits. This is a positive outcome, suggesting that, at the time of the study, the levels of contaminants in the soil were within internationally recognized safety thresholds. Continuous monitoring, as advocated by Ogunbileje et al. [5], Obasi et al. [26], and Emmanuel et al. [27], remains crucial to ensure sustained compliance with these standards and prevent any future exceedance. The comparative analysis of heavy metal concentrations in soils impacted by spent engine oil and palm oil mill effluents highlights the diverse environmental implications of industrial activities in Nigeria. The patterns observed for each metal underscore the need for tailored environmental management strategies to mitigate specific contaminants and protect soil quality.

5. Recommendations for sustainable practices in the industrial sector: Mitigating heavy metal contamination in soil

To address the ecological consequences of heavy metal contamination induced by spent engine oil (SEO) and palm oil mill effluents (POME) for sustainable development, it is crucial to advocate for and implement comprehensive strategies within the industrial sector.

- 1) **Effective waste management practices:** A cornerstone of sustainable industrial practices lies in effective waste management. Industries should invest in advanced treatment facilities to ensure that effluents, particularly those containing heavy metals, undergo thorough processing before release. This not only aligns with responsible production practices (SDG 12) but also safeguards environmental health by preventing the direct discharge of pollutants into soil and water.
- 2) **Circular economy principles:** Embracing circular economy principles is pivotal for reducing the generation of harmful effluents. By adopting practices that prioritize the reuse and recycling of waste materials, industries contribute to the sustainable use of resources. This not only aligns with responsible consumption (SDG 12) but also minimizes the environmental impact of industrial activities.
- 3) **Cleaner production technologies:** Investing in cleaner production technologies is essential for minimizing the environmental footprint of industrial processes. Technologies that inherently generate fewer pollutants, including heavy metals, contribute to responsible production practices. This investment aligns with SDG 12 by promoting efficient resource use and reducing the environmental impact of production.
- 4) **Eco-friendly alternatives:** Industries should actively explore and adopt eco-friendly alternatives to replace or minimize the use of heavy metal-containing substances. This not only addresses environmental protection (SDG 15) but also

fosters innovation in sustainable practices, positioning industries as leaders in responsible production.

- 5) Corporate social responsibility (CSR) programs: CSR programs that focus on environmental conservation and community engagement contribute to responsible consumption and production (SDG 12). By allocating resources for community education on the hazards of heavy metal contamination, industries actively participate in sustainable development initiatives.
- 6) Collaboration with regulatory bodies: Collaborating with regulatory bodies ensures that industries stay informed about and adhere to evolving environmental standards. This collaboration aligns with responsible production practices (SDG 12) and demonstrates a commitment to compliance with global environmental goals.
- 7) Employee training: Investing in employee training creates a workforce that is conscious of its role in mitigating heavy metal contamination. By fostering a culture of responsibility and awareness, industries contribute to responsible consumption (SDG 12) and empower their employees to actively participate in sustainable practices.
- 8) Industry-wide collaboration: Fostering collaboration within industrial sectors is crucial for sharing best practices and collectively working towards minimizing environmental impact. Industry-wide initiatives contribute to responsible consumption and production (SDG 12) by creating a united front for sustainable industrial practices.
- 9) Continuous monitoring and improvement: Continuous monitoring of heavy metal concentrations is essential for informed decision-making. This practice, aligned with responsible production (SDG 12), enables industries to adapt their strategies in real time, ensuring continuous improvement in environmental stewardship.

6. Conclusion

In conclusion, our study evaluating the ecological consequences of heavy metal contamination in soil induced by spent engine oil (SEO) and palm oil mill effluents (POME) provides a comprehensive understanding of the environmental impact of these industrial activities in Nigeria. The analysis of various heavy metals, including zinc, nickel, mercury, manganese, lead, iron, copper, chromium, and cadmium, across contaminated and uncontaminated sites has revealed intricate patterns with implications for soil quality and ecological health.

The elevated concentrations of zinc, nickel, mercury, manganese, lead, iron, copper, chromium, and cadmium in soils contaminated with spent engine oil effluent underscore the potential detrimental effects of this particular industrial activity. These findings align with existing research, reinforcing the persistent nature of certain heavy metals in soils affected by industrial effluents. Notably, the study has contributed to the body of knowledge by highlighting the unique dynamics of lead contamination, where the control site exhibited the highest mean values, emphasizing the importance of site-specific factors in heavy metal distribution.

Despite the observed variations in metal concentrations across sites, the

reassuring result is that, at the time of the study, none of the mean concentrations exceeded the WHO acceptable limits. This suggests a level of compliance with internationally recognized safety thresholds, providing a positive outlook on the current state of soil quality in the study area. However, the study emphasizes the importance of continuous monitoring, as advocated by previous researchers, to ensure sustained adherence to these standards and prevent potential future exceedances.

The diverse patterns observed for each metal across different sites underscore the need for tailored environmental management strategies. Mitigation measures should consider the specific contaminants associated with each industrial effluent and the unique ecological dynamics of the affected area. It is crucial for regulatory bodies and industries to work collaboratively to implement effective waste management practices that minimize the ecological consequences of heavy metal contamination in soils.

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References

1. Ikhajiagbe B. Changes in Heavy Metal Contents of a Waste Engine Oil Polluted Soil Exposed to Soil pH Adjustments. *British Biotechnology Journal*. 2013, 3(2): 158-168. doi: 10.9734/bbj/2013/2374
2. Ogwu C, Azonuche JE, Okumebo VO. Heavy metals content of *Telfairia occidentalis* (fluted pumpkin; order: Violales, Family: Cucurbitaceae) grown in Ebedei (An oil and gas bearing community) Niger Delta, Nigeria. *Quest Journals: Journal of Research in Humanities and Social Science*. 2021, 9(4): 74-78.
3. Kearns B, McDowell S, Moon J, et al. Distribution of contaminants in the environment and wildlife habitat use: a case study with lead and waterfowl on the Upper Texas Coast. *Ecotoxicology*. 2019, 28(7): 809-824. doi: 10.1007/s10646-019-02079-1
4. Isaiah OO, Blessing AG. Environmental Pollutant of Palm Oil Effluent and Its Management in Okitipupa Area of Ondo State, Nigeria. *Journal of Environment Protection and Sustainable Development*. 2020, 6(4): 72-81.
5. Ogunbileje JO, Sadagoparamanujam VM, Anetor JI, et al. Lead, mercury, cadmium, chromium, nickel, copper, zinc, calcium, iron, manganese and chromium (VI) levels in Nigeria and United States of America cement dust. *Chemosphere*. 2013, 90(11): 2743-2749. doi: 10.1016/j.chemosphere.2012.11.058
6. Oriomah C, Adelowo OO, Adekanmbi AO. Bacteria from spent engine-oil-contaminated soils possess dual tolerance to hydrocarbon and heavy metals, and degrade spent oil in the presence of copper, lead, zinc and combinations thereof. *Annals of Microbiology*. 2014, 65(1): 207-215. doi: 10.1007/s13213-014-0851-x
7. Asiamah JY, Otwe EP, Danquah A, et al. Effect of spilled engine oil on soil quality indicators and physiological performance of maize, cowpea and sorghum. *African Journal of Environmental Science and Technology*. 2021, 15(7): 262-269. doi: 10.5897/ajest2021.2999
8. Salam LB, Obayori SO, Nwaokorie FO, et al. Metagenomic insights into effects of spent engine oil perturbation on the microbial community composition and function in a tropical agricultural soil. *Environmental Science and Pollution Research*. 2017, 24(8): 7139-7159. doi: 10.1007/s11356-017-8364-3
9. Anerua FA, Azonuche JD. Information and communication technology (ICT): A necessary tool for food and nutrition education issues and challenges. *Multidisciplinary Journal of Research Development*. 2010, 14(4).

10. Wang P, Chen H, Kopittke PM, et al. Cadmium contamination in agricultural soils of China and the impact on food safety. *Environmental Pollution*. 2019, 249: 1038-1048. doi: 10.1016/j.envpol.2019.03.063
11. Alsherif EA, Al-Shaikh TM, Abdelgawad H. Heavy Metal Effects on Biodiversity and Stress Responses of Plants Inhabiting Contaminated Soil in Khulais, Saudi Arabia. *Biology*. 2022, 11(2): 164. doi: 10.3390/biology11020164
12. Napoletano P, Guezgouz N, Di Iorio E, et al. Anthropogenic impact on soil heavy metal contamination in riparian ecosystems of northern Algeria. *Chemosphere*. 2023, 313: 137522. doi: 10.1016/j.chemosphere.2022.137522
13. Panagopoulos T, González Duque JA, Bostenaru Dan M. Urban planning with respect to environmental quality and human well-being. *Environmental Pollution*. 2016, 208: 137-144. doi: 10.1016/j.envpol.2015.07.038
14. Azonuche JE, Anyakoha EU. Construction criteria for functional apparel for caregivers in Day care centres in Delta State. *Journal of Home Economics Research (JHER)*. 2018, 25(1): 1-12.
15. Lee KH, Noh J, Khim JS. The Blue Economy and the United Nations' sustainable development goals: Challenges and opportunities. *Environment International*. 2020, 137: 105528. doi: 10.1016/j.envint.2020.105528
16. Peter AF. Spent engine oil and industrial effluent induced heavy metals and changes in soil and air potato quality. *Soil and Environment*. 2023, 42(1): 1-12. doi: 10.25252/se/2023/242838
17. Ilyas M, Ahmad W, Khan H, et al. Environmental and health impacts of industrial wastewater effluents in Pakistan: a review. *Reviews on Environmental Health*. 2019, 34(2): 171-186. doi: 10.1515/reveh-2018-0078
18. Golia EE. The impact of heavy metal contamination on soil quality and plant nutrition. Sustainable management of moderate contaminated agricultural and urban soils, using low cost materials and promoting circular economy. *Sustainable Chemistry and Pharmacy*. 2023, 33: 101046. doi: 10.1016/j.scp.2023.101046
19. Long Z, Huang Y, Zhang W, et al. Effect of different industrial activities on soil heavy metal pollution, ecological risk, and health risk. *Environmental Monitoring and Assessment*. 2021, 193(1). doi: 10.1007/s10661-020-08807-z
20. Pushpanjali, Sharma KL, Venkanna K, et al. Industrial pollution and soil quality—A case study from industrial area, Visakhapatnam, Andhra Pradesh, India. In: Mishra RK, Kumari CL, Chachra S (editors). *Smart Cities for Sustainable Development*. Springer; 2022. pp. 327-334. doi: 10.1007/978-981-16-7410-5_20
21. Lai RWS, Kang HM, Zhou GJ, et al. Hydrophobic Surface Coating Can Reduce Toxicity of Zinc Oxide Nanoparticles to the Marine Copepod *Tigriopus japonicus*. *Environmental Science & Technology*. 2021, 55(10): 6917-6925. doi: 10.1021/acs.est.1c01300
22. Hu HW, Wang JT, Li J, et al. Long-Term Nickel Contamination Increases the Occurrence of Antibiotic Resistance Genes in Agricultural Soils. *Environmental Science & Technology*. 2016, 51(2): 790-800. doi: 10.1021/acs.est.6b03383
23. Khademi H, Gabarrón M, Abbaspour A, et al. Environmental impact assessment of industrial activities on heavy metals distribution in street dust and soil. *Chemosphere*. 2019, 217: 695-705. doi: 10.1016/j.chemosphere.2018.11.045
24. Beardsley CA, Fuller KZ, Reilly TH, et al. Method for analysis of environmental lead contamination in soils. *The Analyst*. 2021, 146(24): 7520-7527. doi: 10.1039/d1an01744f
25. Dhal B, Thatoi HN, Das NN, et al. Chemical and microbial remediation of hexavalent chromium from contaminated soil and mining/metallurgical solid waste: A review. *Journal of Hazardous Materials*. 2013, 250-251: 272-291. doi: 10.1016/j.jhazmat.2013.01.048
26. Obasi PN, Akudinobi BEB. Heavy metals occurrence, assessment and distribution in water resources of the lead–zinc mining areas of Abakaliki, Southeastern Nigeria. *International Journal of Environmental Science and Technology*. 2019, 16(12): 8617-8638. doi: 10.1007/s13762-019-02489-y
27. Emmanuel E, Sombo T, Ugwanyi J. Assessment of Heavy Metals Concentration in Shore Sediments from the Bank of River Benue, North-Central Nigeria. *Journal of Geoscience and Environment Protection*. 2018, 6(4): 35-48. doi: 10.4236/gep.2018.64003

Commentary

Traditional knowledge in the approach to sustainability: Making sense of Bhutanese gross national happiness and Buen Vivir in Bolivian constitution

Folco Ferraris¹, Silvio Cristiano^{1,2,*}

¹ Ca' Foscari International College, Università Ca' Foscari Venezia, 30123 Venice, Italy

² Department of Architecture, Università degli Studi di Firenze, 50121 Florence, Italy

* **Corresponding author:** Silvio Cristiano, silvio.cristiano@unifi.it

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Abstract: In the past few decades, due to the global environmental crisis humanity is facing, a sudden growth in environmental policies and sustainability strategies has been registered. This article discusses two of such policies, namely that of Gross National Happiness (GNH) in the Himalayan country of Bhutan and the inclusion of the concept of Buen Vivir (BV) in the Bolivian Constitution, through a critical analysis—based on political ecology approaches—of their implementation within state policy and their wider implications within the global discourse on the so-called “sustainable development” paradox. This paper highlights the role that the aforementioned policies might play in the path to decolonization, seeing as how they draw inspiration from their own local contexts and values instead of those provided by the Global North, more specifically focusing on their ancestral and traditional knowledge to supposedly guide the countries’ policy-making process. Although several points of criticism are identified in both policies, innovativeness is detected in their potential to offer alternative views on human wellbeing, both for global southern and global northern contexts, as their original intent would be to remarkably operate outside of the Western framework of development based on Gross Domestic Product (GDP) and economic growth. GNH appears to be mostly oriented toward supporting political national budget discussion and allocation, while BV acts at a higher level (constitutional), thus also inspiring overall politics.

Keywords: sustainable development; decolonization; global south; paradigm shift

1. Introduction

“Fiction isn’t bad. It is vital. Without commonly accepted stories about things like money, states, or corporations, no complex human society can function. [...] But stories are just tools. They shouldn’t become our goals or our yardsticks. When we forget that they are mere fiction, we lose touch with reality. Then we begin entire wars ‘to make a lot of money for the cooperation’ or ‘to protect the national interest’. Corporations, money, and nations exist only in our imagination. We invented them to serve us; why do we find ourselves sacrificing our life in their service.”—Homo Deus: A Brief History of Tomorrow [1].

In the past few decades, there has been an increasingly prominent insurgence of concepts originally devised in what is today known as the “Global South”, mostly in reaction to the pervasive Western, capitalistic way of thinking about the West’s one-size-fits-all agenda, a sort of logic that no-matter-what prioritizes economic growth and encourages an individualistic approach to work, the failures of which, due to its inability to be applied to any geopolitical area whatsoever and to the evident widening of inequalities currently taking place on a global scale, are now being analyzed by countless scholars coming from all around the world [2]. Recently, in the Global

South, some innovation models created and led by indigenous organisations have been making their way into state legislation; likewise, widespread religions have been showing their deep influence within political contexts.

Throughout this brief paper, we will be illustrating and analysing two cases of environmental policies that supposedly adopt a decolonial approach [3,4] to innovation, challenging mainstream environmental narratives while pursuing greater social balance and justice, namely the Bhutanese government's policy of Gross National Happiness (GNH) and the Bolivian Constitution's policy of *Buen Vivir*. First, we will provide the historical, cultural, geographical, and economic context of the environmental policy and the country in question. Secondly, we will illustrate the policy's highlights and state the tools we will be using for our critical assessment. Finally, we will be engaging in a discussion regarding such policies with a more attentive focus on their strengths and weaknesses within the context of Western economic and ideological domination, linking such discussion to our findings and personal knowledge.

Our critical assessment of the aforementioned policies presents itself with the goal of analysing possible values and assumptions that underlie innovation in these alternative development-based conceptual and practical frameworks. More specifically, we will be placing the focus on the role of Buddhist beliefs [5] in the implementation and operationalisation of GNH in the case of Bhutan and on the difficult translation of informal indigenous beliefs within state institutions in the process to cultural decolonisation and plurinationality in the case of Bolivia.

A matter that is of great concern and that we will be trying to critically analyse is the following: Can the hereby presented policies serve as a practical tool for aiding communities, leaders, and governments in the implementation of measures centred on both human and environmental well-being? How do they operate on the grounds of a capitalist economy? Additionally, what if such state endorsement of indigenous and/or alternative approaches to development were actually an exploitation of the inclusion and diversity rhetoric and a disguise for maintaining the business-as-usual Western-style approach to development?

2. Materials and methods

The assessed policies are illustrated in sections 2.1 and 2.2 by using a selection of political ecology approaches [6,7] for critical thinking and assessment; where available, further details on approaches are provided on the occasion of their first appearance throughout the following sections.

2.1. Gross national happiness in Bhutan

Starting from Gross National Happiness, this term originated and is currently employed in the tiny Asian country of Bhutan (38,117 km²), situated in the Greater Himalayas and enclosed by the two most populous nations on Earth (China and India), with a population of under 800,000 [8] (distributed 38% in urban areas and 62% in rural ones), mainly professing the Mahāyāna branch of Buddhism (which has been the dominant religion there since the seventeenth century), and a territory covered for the 71% by forest [9]. The World Bank has ranked Bhutan as a lower middle-income developing country [9], and the United Nations has classified Bhutan as one of the

world's "Least Developed Countries" (LDCs), even though there have been some critiques aimed at the indicators employed by the UN for determining which countries are to be considered LDCs [10].

Historically, Bhutan purposely limited exposure to the outside world, taking advantage of its geographically remote location [11]. One element of Bhutan that makes it stand out on a global level is that not only is it the only carbon-neutral country in the world (and has pledged to continue to remain so in the future), but it is even "carbon negative" [12], as it absorbs three times more carbon emissions than it emits; additionally, the Bhutanese Constitution requires that 60% of the country's land be covered with forest [11].

When Western economists started visiting Bhutan at the beginning of the 1970s, they regarded it as "poor" when analysed under the lens of its Gross Domestic Product (GDP) [13]. In response to this, in 1972, Bhutan's fourth king, Jigme Singye Wangchuck, coined the expression "Gross National Happiness" (GNH), but it was not until the late 1980s that it started being widely employed as the country's guiding philosophy for managing economic development and embracing the inevitable oncoming modernisation process while preserving the country's traditions, institutions, spiritual values and sovereignty [14]. This was deemed extremely vital, as Bhutan's political and economic opening to outside ideas and institutions had already begun a few decades earlier through diplomatic ties with (mostly) India and admission to the United Nations in 1971 [11]. In 2004, Bhutan started operationalising the GNH policy, and in 2008 it developed a GNH index based on country-wide surveys [13].

The King wanted the country to embrace the idea that sustainable development should take a holistic approach towards notions of progress and give equal importance to non-economic aspects of well-being, placing the focus on prosperity and happiness as the main aims of development [15]. GNH represents a new approach to measuring a nation's wealth, promoting education and human capital within a human-centred framework of development, rather than a profit-centred one; as remarked by Bhutan's 5th King, it is a sort of "development with values" [11]. According to a global study conducted in 2007 on subjective well-being, "Bhutan ranked eighth out of 178 countries", also being the only country in the top 20 "happiest" countries that has a very low GDP [13].

Because of its peculiarity, the philosophy of GNH received international recognition when the UN General Assembly made "the conscious pursuit of happiness a fundamental human goal in the resolution "Happiness: Towards a holistic approach to development" [13], and it is being widely discussed internationally as a plausible development alternative to the Western framework of GDP.

2.2. Buen Vivir in the Bolivian constitution

Bolivia is an ethnically heterogeneous South American country that has experienced economic inequalities and hierarchical power relations since its colonial conquest [16]. Some of the country's history can be analysed in order to understand what led the government to recently adopt policies related to the concept of "Buen Vivir", a general grasp of which is needed in order to understand the current political, cultural, and economic framework in Bolivia.

Buen Vivir (BV, sometimes also referred to as “Vivir Bien”) is a concept derived and inspired by Andean Indigenous cosmologies, specifically from the Quechua and Aymara Indigenous Peoples of Bolivia, Ecuador, and Peru [17]. It is derived from the Kichwa “sumak kawsay” (roughly translating into “a life in plenitude”), a concept that, along the Aymaran one of “suma qamaña” (a harmonious balance of material and spiritual elements), has gained popularity within popular discourse since the indigenous social movements of the 1990s [18] and the election of “governments of the Latin American new left”, that “allowed the expression of indigenous knowledge and traditions that were oppressed, minimised or subordinated over centuries” [19]. It is a living practice that, since its beginning, has put the focus on attaining collective well-being through a few main principles, such as reciprocity, complementarity, and relationality, which are to be applied to humans as well as non-human and cosmological beings. BV also endorses a multi-directional, non-linear progression of history and development [19]; it distances itself from the mainstream idea of progress, usually perceived as a notion “based on a productivist path and a mechanistic vision of economic growth” [20]. A central concept of BV is that of the “pachamama” (Mother Nature), a living entity to be safeguarded through respectful and reciprocal engagement between human society and nature [18].

Because of its plurinational descent, BV is not a homogenous philosophy, as it encompasses a diversity of knowledge and philosophies, therefore potentially engendering multiple interpretations of BV itself [18], which interact in dialogue with each other without hierarchies [19]. As described by Gudynas [19], BV “is not a static concept, but an idea that is continually being created”, and can thus work as a unifier between heterogeneous political demands [16]. BV’s wisdom can be explicated through the Andean cross “Chakana” (**Figure 1**), which illustrates its main constituents engaging with each other in accordance with natural elements.

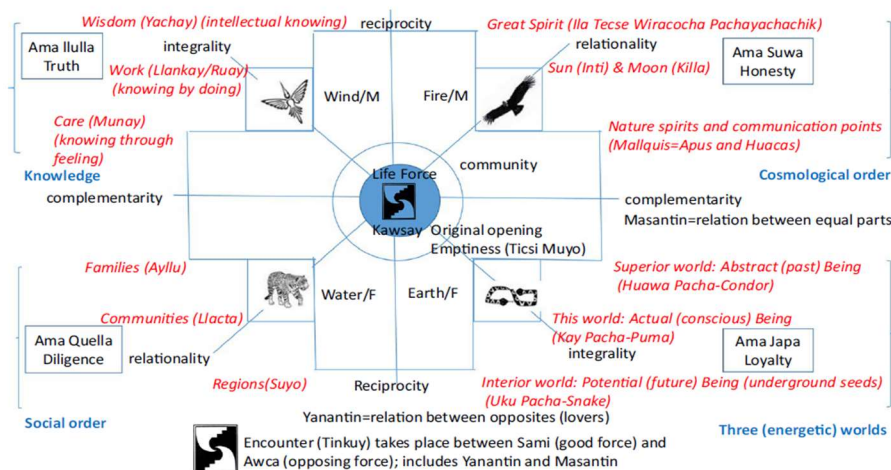


Figure 1. The Andean cross “Chakana” [21].

3. Results

3.1. Gross national happiness in Bhutan

First and foremost, in order to contextualise the concept of GNH, it is important to deliver a general account of how exactly the term “happiness” is to be understood

in the context of Mahāyāna Buddhism and its teachings, to which is attributed the emphasis on happiness as the central goal of human life [14]. Happiness is a multidimensional concept, focusing on a collective pursuit of it rather than merely on subjective well-being [22], which sees material and spiritual development as complementary [9]. GNH is then meant to substantially orient the Bhutanese people towards happiness by improving their current conditions and, therefore, decreasing the insufficiencies measured in the system that we will shortly go on to explain.

The GNH policy rests on four main pillars (showcased in **Figure 2**) that very much resemble the way in which leadership and power relations are rooted in the traditional Buddhist context [13]: Good governance, sustainable socio-economic development, cultural preservation, and environmental conservation. These are further broken down into nine domains: psychological well-being, health, education, time use, cultural diversity and resilience, good governance, community vitality, ecological diversity and resilience, and living standards [15]. Within the framework of these nine domains, 33 indicators and 124 variables can be identified, with each variable representing a building block of the overall well-being of the Bhutanese people [15]. For instance, some of the most relevant indicators related to their domain of belonging might be “literacy” for education, “political participation” for good governance, “cultural participation” for cultural diversity and resilience, and so on [23].

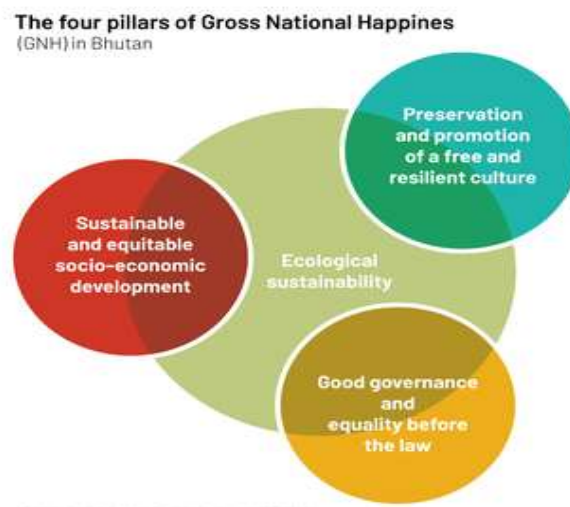


Figure 2. The four pillars of Gross National Happiness (GNH) in Bhutan.

Source: https://en.wikipedia.org/wiki/Gross_National_Happiness.

The GNH index is measured through data drawn from periodic surveys, the results of which are analysed through the lens of gender, age, occupation, and region [22], which clearly are crucial factors that contribute to such a measure’s multidimensionality and depth. Needless to say, people aren’t expected to be sufficient in each of the 124 variables in order to be registered as happy: diversity in how one attains a fulfilling life is also taken into account [22]. The domains of GNH can be weighted by the Bhutanese government by using two kinds of thresholds [15]:

- Sufficiency threshold: The minimum an individual needs to meet sufficiency in each of the 33 indicators;

- Happiness threshold: Poses itself the question, “How many domains or in what percentage of the indicators must a person achieve sufficiency in order to be understood as happy?”.

It is also important to note that self-report indicators are weighed as less important than others since they are subjective. The following table (**Table 1**) helps us understand the different weights ascribed.

Table 1. Weights ascribed by the GNH index to different domains [23].

Domain	Indicators	Weight
Psychological wellbeing	Life satisfaction	33%
	Positive emotions	17%
	Negative emotions	17%
	Spirituality	33%
Health	Self-reported health	10%
	Healthy days	30%
	Disability	30%
	Mental health	30%
Education	Literacy	30%
	Schooling	30%
	Knowledge	20%
	Value	20%
Cultural diversity and resilience	Zorig chusum skills (Thirteen arts and crafts)	30%
	Cultural participation	30%
	Speak native language	20%
	Driglam Namzha (Etiquette)	20%
Time use	Work	50%
	Sleep	50%
Good governance	Political participation	40%
	Services	40%
	Government performance	10%
	Fundamental rights	10%
Community vitality	Donation (time and money)	30%
	Safety	30%
	Community relationship	20%
	Family	20%
Ecological diversity and resilience	Wildlife damage	40%
	Urban issues	40%
	Responsibility towards environment	10%
	Ecological issues	10%
Living standard	Per capita income	33%
	Assets	33%
	Housing	33%

After calculations have been made, the population is differentiated into four sub-groups, namely: unhappy (under 50% of the highest scores set out), narrowly happy (50%–66%), extensively happy (66%–77%) and deeply happy (77%–100%) [15].

GNH has even been inscribed in Article 9 of the Constitution of Bhutan (2008), by which “The State shall strive to promote those conditions that will enable the pursuit of Gross National Happiness” [15]. Thus, policies and programmes advanced by Bhutan’s constitutional monarchy have to be coherent with the aforementioned article. Such a mindset dates back hundreds of years: citing a Bhutanese legal code instituted after the country’s unification in 1729, “if the government cannot create happiness for its people, there is no purpose for the government to exist” [15].

In order to analyse the hereby presented policy of Bhutan’s GNH, we will be employing several tools that are of common use within the field of environmental politics and policies, namely the Easterlin paradox [24], leverage points, the systemic reality of sustainability and the three pillars of sustainability, the human-nature dichotomy, integrated approaches, cultural paradigms and, finally, the GDP-GNH dilemma.

3.2. Buen Vivir in the Bolivian constitution

Originally born as an indigenous belief, BV has recently made its way into several fields—such as political theory, political economy, and legal studies—but, most importantly, into Ecuador and Bolivia’s state legislation. In Bolivia, BV has been employed since 2016 as the guiding value (and a sort of backbone of state policy-making) of the National Development Plan (“Plan Nacional de Desarrollo”) [16], and it was finally inscribed in the Constitution of 2009 when the country’s plurinationality and interculturality (“Estado Plurinacional de Bolivia”) were finally recognised, which translated into a set of ethical and moral guidelines for the government to comply with in the process of decolonisation [25], intended as “the elimination of racial and cultural discrimination and the strengthening of indigenous knowledge and ideas” [16]. Bolivia’s Constitution promotes a “plurinational framework that recognises Indigenous Peoples as nations with territorial rights” [17], while Law 71—*Ley de Derechos de la Madre Tierra* “regulates the rights of nature and the environment in accordance with the principles of Buen Vivir” [26]; this last law has been proven to be modestly effective in supporting national forest cover, thus displaying how the institutional recognition of indigenous principles can aid in the protection of the environment [26].

Such remodelling of legislation came about during Evo Morales’ administration (2006–2019), Bolivia’s first president of indigenous (Aymara) descent who, by “combining an indigenous cause with increasing anti-globalisation sentiments,” set out to translate political alternatives of indigenous origin into state policy [16]. His electoral win in January 2006 represented a victory for several social movements, indigenous groups, and peasant unions, and so “high hopes were expressed for a radical, democratic, state-transformation project based on indigeneity” [16].

In order to analyse the challenging implementation of indigenous discourses within state policy, innovative conceptual tools are needed, and so we will be resorting to decolonialism, bottom-up approaches and inclusivity, sustainable development (and the extractive exploitation of indigenous territories), the Pluriverse (post-development

thinking frameworks [2]), philosophy of science, the Kuhn Cycle [27], Barry Commoner's Laws of Ecology [28], cultural appropriation and political translation, the indigenous experience and the systemic thinking iceberg [29] for conducting our critical analysis of the Buen Vivir policy in Bolivia.

4. Discussion

4.1. Gross national happiness in Bhutan

For our discussion regarding the policy of GNH, we would like to start with the Easterlin paradox [24] which, as significantly studied in the past few decades, proposes that increases in income do not translate into increases in happiness over the long term [11]. According to the Easterlin paradox, despite higher incomes generally implying higher levels of life satisfaction in the short term, when considering long-term growth happiness will not increase directly with income, mainly due to external causes such as social comparison [24]. Indeed, income and happiness go together only up to a certain point, because pursuing materialistic growth is actually associated with lower levels of well-being and life satisfaction, which is detrimental to both the individual and the environment [30]. A better understanding of subjective aspects of well-being, which GNH is proposing to do, would be favourable in regards to recalibrating development towards an economy that sees economic growth as a means through which to achieve human potential, with individuals being put at its very centre.

Talking about income increases, one of the most significant challenges that Bhutan may encounter in the near future is managing consumption levels in a society currently undergoing rapid urbanisation and modernisation (which are nonetheless swiftly changing cultural identities), trying to embrace the aspects of modernity that “provide individual and societal benefits while avoiding those aspects that lead to undesirable social, cultural, and environmental change” [30]. Furthermore, as outlined by Munslow and O'Dempsey [31], globalisation is known to increase inequalities, nationally and internationally. This last point is also linked to the notion of “degrowth”, which proposes that humankind, instead of struggling to grow constantly, should redefine development by resizing its economic and social systems so as to make them more long-term sustainable.

As reported by Brooks [30], Meadows et al. [32] suggest that, in order to achieve large-scale change, before a shift of deeply ingrained beliefs and practices that affect behaviour, there must first be an envisionable alternative to the present situation. In Bhutan, such change is being achieved through formal and informal political institutions, as well as through social institutions such as Buddhism in which Bhutanese identity is rooted, whose beliefs shape values and perceptions and can promote sustainable ways of living. The state has made active efforts to link Buddhist teachings with environmental conservation, as can be seen from the many references to Buddhist philosophy in several government documents [30] and the emphasis that has been placed on the concept of “Buddhist leadership” [13,33], which goes beyond Western leadership definitions. These institutions' far-reaching potential within Bhutanese society can thus serve as an effective leverage point for achieving change in the development discourse. Another identifiable crucial leverage point would be that of campaigning, which in Bhutan has likely played an important role in “making

the public aware of the efforts to maximise GNH” [30], and the same goes for the periodic surveys, the answers to which promptly highlight which factors the state can work on for introducing policies in line with the recommendations made by the public. Curiously, in Bhutan, it seems that the public’s understanding of Buddhism is actually increasing with development rather than dissolving because of it [30], which represents a peculiar trend when analysing the general relationship between economic growth, globalisation, and religions’ spread.

Amongst the strengths displayed in the GNH policy, we can surely notice a strong view of mutual interdependence between ecology, society, and economy, with the planet taking precedence over the people, which form healthy ecosystems that in turn provide the basis for economies to flourish [13]. All this is strictly abiding by the systemic reality of sustainability, as displayed in **Figure 3**.

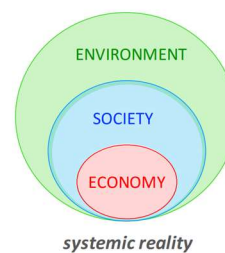


Figure 3. Own re-elaboration of the strong sustainability approach.

Source: Internal educational re-elaboration of public domain images.

By conceiving the world’s system in such a way, GNH deviates from the human-nature dichotomy that has led humanity to become alienated in relation to nature, and instead “more optimistically assumes the possibility of harmonious co-existence between mankind and nature” [13]. Further elaborating on this, GNH actually adds a fourth dimension to the systemic reality of sustainability, that of governance, which has the role of balancing the three other pillars through policy-making [13]. As outlined by Grugel and Uhlin [34], the marginalised and poor communities in the Global South “do not figure prominently in mainstream accounts of global governance,” so there is an urgent need for more inclusive state governance. Through GNH, the state provides Bhutanese citizens with enabling conditions for participating actively in the development of the nation and in the attainment of both individual and collective well-being [11].

By conducting the period surveys for measuring GNH in several regions throughout the country, considering several multidimensional indicators as well as taking into consideration the personal context of each individual, the Bhutanese government is able to gather information on the national distribution of resources (and act upon it if they aren’t being distributed fairly) and different needs in different contexts [15], thus deploying an integrated approach in its assessment techniques, which should serve as an adequate method for defining environmental policies. Over time, periodical measures of the national GNH Index will provide, as stated by Ura et al. [22], a “nuanced picture of the composition, diversity, and evolution of GNH across Bhutan,” which can be analysed by experts for determining what can be improved.

For what concerns the weaknesses, first of all, there is great concern over the reliability of the surveys’ answers, for a variety of reasons. Self-reports, for instance,

may not be wholly trustable because people may be strongly biased due to their current emotional and mental state and thus base well-being assessments solely on the information at hand at that moment [14]. Subjective well-being indicators are quite tricky because they might be interpreted (and misinterpreted) in several fashions by their receivers, who would thus be giving out answers difficult to generalise, which is a crucial step in understanding the bigger picture of the case study in question and acting upon its shortcomings.

One must also bear in mind that, if the GNH Index surveys were used for international comparisons, a “cultural translation” would be required along with the obvious linguistic one, because happiness is a cultural trait too: the extent to which it is shown and expressed depends on cultural norms, just like the way in which questions are phrased and terms with slightly different connotations are used can change the content of the question entirely [14]. In relation to this, Brooks [30] actually argues that despite Buddhist principles clearly not representing universal values, equivalents of these may be found in many world religions (and even within Western secular contexts), which could be employed by other nations for supporting alternative visions of progress.

Still focusing on the surveys’ reliability, there might be other negative influences in the data-gathering process: The survey takes at least 5–6 h to complete, a time length that could easily bore respondents, therefore lowering the possibilities of receiving genuine feedback [15]. Bhutan’s geographical and cultural homogeneity also play an important part in the process, because carrying out surveys in a much more diversified country (i.e., China, India, or the US) would present experts with several more challenges [15].

For what concerns cultural homogeneity in Bhutan, though, this is not entirely true, as the 33 GNH Index indicators do not take into consideration the cultural values of 25% of Hindus and 5% of other faiths (Muslims and Christians) living mostly in southern Bhutan, which shows a clear case of cultural intolerance: while trying to preserve Bhutanese culture, the government is also strictly defining what Bhutanese culture is merely in relation to Buddhist-centred values [15]. Even in instances where religion may serve as a means through which to gain strong social cohesion (and thus help lead to more just and sustainable societies), there is a risk that it might negatively impact achieving social equity considering how many widespread religions rely on very strict biases (which might take the form of patriarchy, discrimination based on race, casteism, and so on), thus resulting in marginalisation of countless minorities and communities.

As with most major innovations and approaches for measuring human well-being, Bhutan’s policy of GNH is proving to be flawed from a series of social, ethical, cultural, political, and practical perspectives. At the same time, one must not forget that the expectations coming from international recognition of this policy would be too high to meet even for fully-developed countries, and so we must take into consideration that Bhutan is currently welcoming the arduous challenges that accompany the development process in an unconventional way that puts the focus on human and environmental capital rather than on economic growth.

It is imperative to recognise the value of Bhutan’s current development model, and even more so to envision how it could also be integrated with and improved

through more recent, international research-backed reports such as the OECD's "Guidelines on Measuring Subjective Wellbeing", which represents one of the first official attempts at measuring subjective well-being [15].

Finally, Bhutan's experience with GNH provides evidence of how GNH and GDP should work as complements instead of substitutes. Many of the problems associated with the economic progress pursued through GDP may indeed "encourage activities that reduce rather than enhance long-term well-being" [35], with rising GDP not necessarily resulting in a higher quality of life since it is a "misleading indicator of progress in the sense of well-being" [2], but by combining these two systems, innovative frameworks for both economic and human growth could be tested out and, eventually, employed.

4.2. Buen Vivir in the Bolivian constitution

Today, re-interpreted In a modern connotation, BV has the potential of renewing both social and economic relations on the basis of the stated values, especially for indigenous communities, which are generally known to experience marginalisation on the basis of a lack of or limited access to basic public services [17], as well as in relation to the discussion on societal alternatives, resulting in an evident case of epistemic ide [36]. Additionally, poor communities tend to suffer the most from the negative effects of globalisation and climate change [31]. Through the reconstruction of traditional BV-related worldviews, indigenous movements are seeking to reappropriate their rights to self-determination and territoriality [25], as well as strengthen cultural identities [19].

BV represents a decolonial approach to development in its questioning of the problematic assumptions about the homogenising, disempowering conception of power and the socio-ecological systems underlying development as intended by the Westernised world, which has historically disregarded indigenous knowledge in light of its foreignness to the functionings of scientific knowledge coming from the West [17]. As argued by Lang [36], colonialism may be over, but coloniality that is, "all the cultural colonial legacies that persist and multiply even after colonialism as such has ended," on the other hand, still very much persists in this day as the "darker side of modernity". Global injustice, as argued by Grugel and Uhlin [34], "is embedded in political, economic, social and cultural processes that have a global dynamic," even though, clearly, "it is difficult to trace and allocate responsibility in any simple fashion." In the BV worldview, Western knowledge isn't predominant over indigenous knowledge, but the two are complementary and in discussion with each other.

BV also breaks with Western assumptions regarding the society-nature dichotomy, adopting a systemic perspective that makes us rethink the way people and nature become political [25]; their separation isn't feasible, as one contains the other. By criticising development, BV causes tensions at a deeper level and questions the very foundations of modernity, or rather the ontology (a particular worldview) of modernity, which has been ruling the world for the past centuries. On these political grounds, many ontologies that are considered alternatives can meet and interact [19].

Most BV initiatives function through a system of indigenous grassroots organisations that promote innovation from below; seeing how innovation is the

process of developing goods and services for the collective good, they believe that the decision-making process has to be carried out from the bottom up [17], also by taking into account the voices of the communities most marginalised. A great emphasis is placed on the concept of innovation which, since it is deeply entwined with politics and history, may very naturally “perpetuate the logic and ideals of colonialism” [17], i.e., consider “developing” countries to be less wealthy than developed countries due to their lack of innovation while not questioning the centuries of colonisation that have culminated in nowadays’ distribution of wealth amongst the world’s continents. BV goes directly against such a colonial perspective by reimagining what it means to innovate.

Moreover, for the moment, the countries belonging to the Global North do not seem to be engaging in discussions regarding BV practices and their implementation within governmental frameworks [37], thus not showing interest in development paths that stray from their own standards. The UN system, which is based on the paradigms of the most developed countries in the world and abides by their rules, has failed to “provide a financing mechanism to help developing countries achieve the structural transformations required for broad-based economic growth”, due to both the economic interests of the North within the South as well as the difficulties of identifying where to invest in the developing nations for obtaining the biggest benefits in terms of development [38]. As described by Gray and Gills [39], even though the debates on South-South economic cooperation and emancipation from the North are increasing, some are still skeptical regarding the fact that, even though South-South cooperation exists, the countries belonging to the Global South would still be operating under the global capitalist development paradigm, thus still placing them in a position of submission to the Global North. In this regard, by analysing the rise in global carbon emissions linked to the emergence of some countries historically belonging to the South (mainly India and China), Fuhr [40] argues that it might be too inaccurate to still cling onto the term “Global South”, as it encompasses an extremely vast array of nations that contribute to and are affected by global change in very different ways and which do not share a common view nor pursue the same interests on the international political stage.

Passing onto the next point, BV principles might appear similar to those praised by Sustainable Development (SD) (An economic and political concept that started being applied after the 1992 Rio Declaration on the Environment and Development [18]; it is described by the Brundtland Report [44] as “development that meets the needs of the present without compromising the ability of future generations to meet their own needs”), but their core implications are different: while BV is at the heart of an indigenous knowledge-based framework of development and growth, SD does not differ nor detaches itself from Western notions of (purely economic) development, as it views nature as a commodity and economic growth as a driver for wellbeing; it is dominated by global institutions that aim at global conformity to Western ideals [18]. BV can then try to succeed in the areas where SD has failed, i.e., achieving long-term sustainability and communal well-being.

As for the present, the main challenge rests in the state implementation of BV. Even though BV’s advancers haven’t properly addressed Bolivia’s political economy [25], it should be understood as being in constant dialogue with diverse contemporary

outlooks in search of a sustainable future. For instance, the notion of BV is certainly envisionable within the context of a Pluriverse, which brings together several post-development thinking frameworks that aim at reversing the key legitimising assumption of Western development, which sees indigenous knowledge as incompetent and believes it must be replaced with Western knowledge [2].

If indigenous knowledge is to be acknowledged and applied at national and international levels, the epistemological branch of philosophy of science, which delves into the complex relations taking place between scientists, politics, and the public, must ponder what sort of knowledge can be considered true scientific knowledge (in other words, is the Western empirical method for conducting research the only possible one?) and ask itself how to quantitatively or qualitatively assess indigenous communities' scientific literacy to determine whether their critiques and suggestions for research production are well-founded or not. Clearly, the practice of science itself often raises philosophical questions [41], and this also applies to indigenous knowledge.

In relation to this last point, we might take as a reference the Kuhn Cycle, which serves as a representation of what was just stated. The Kuhn Cycle, outlined in his work "The Structure of Scientific Revolutions", is used to represent the cycle by which so-called "normal science" continuously comes to exist. Generally speaking, "normal science" will experience a "model drift" due to the input of "pre-science", leading in turn to a "model crisis" and, therefore, to a "model revolution" and a "paradigm change"; this new paradigm will, inevitably, come to be considered itself as the new "normal science" [27]. As for nowadays, "normal science" consists of Western-compliant knowledge which, considering its proven inadequacy to address the global environmental crisis we're currently facing, seems to be undergoing a period of serious "model crisis"; in the meantime, the so-called "model revolution" might eventually be triggered by indigenous knowledge (or, for the sake of the example, by any other post-development thinking framework), which, after leading to a "paradigm change", would start to be perceived as "normal science" again, and so on. This goes to show that Western science, despite being predominant nowadays, will probably come out of its current crisis deeply altered, thus leading many societies to adopt a new paradigm of development.

Yet another important issue to be addressed is that of measurement: for BV-based policies to become internationally recognised and, eventually, implemented, there must first be some indicators that quantitatively demonstrate the system's efficiency; otherwise, they will always be overlooked by quantitative data-driven governments [18]. Under this perspective, the aforementioned Bhutanese policy of GNH is proving to be more effective because it exhibits clear results obtained through national surveys.

Passing onto the cultural side of BV, an important aspect of the *suma qamaña* view, autochthonous to Bolivia, is that it is deeply linked to the natural, cultural, and social landscape of the region [36], and so it cannot be directly applied to other contexts; people belonging to different cultural contexts will have to establish and employ their own view of BV [19]. Bolivia, though, can serve as a case study for other countries in adopting a critical approach toward the challenges and advantages that adhering to a similar developmental framework might imply.

Due to the recent deep political perpetration of BV concepts within Bolivia's state institutions, BV discourses have been to some extent appropriated by the state, despite indigenous movements and social organisations' attempts at reappropriating them and using them as "self-emancipatory tools" [25]. Even though national elites are known for conceiving indigenous knowledge as a backward and folkloric way of thinking that must be "tolerated as a sign of respect for the past but not valued as a knowledge system that might truly contribute to addressing current and future humankind challenges" [17], it did not take them long to recognise the true potential of BV narratives for maintaining and even perpetuating the business-as-usual development framework, thus appropriating it for their policy agenda [25]. Although BV principles inscribed in the Bolivian Constitution advocate for the importance of bottom-up approaches and inclusivity of the marginalised over a logic merely centred on economic growth, which can significantly reduce potential shortcomings and oversights thanks to the several points of view (or paradigms) taken into account in the policy-making process, all BV-related policies introduced so far have been decided by a single actor, the state, thus directly going against "the idea of BV being a plural construction from actors at all levels" [18]. Likewise, in Ecuador, despite the BV approach already being implemented in the new Constitution, the State still seems to be following in the footsteps of former development strategies, still far from attaining the goals it had previously set for itself [37]. It seems that the governments were able to convert spaces formerly claimed by indigenous groups into spaces now dominated by the state itself, thus limiting the indigenous peoples' ownership in the decision-making process as well as their understanding of it [42]. Such a state centralisation of the decision-making process can also come across as a sign of "continuing coloniality" [16]; the governments of Bolivia and Ecuador, thus, were not actually willing to "engage in intercultural dialogue and truly change how state decision-making takes place," as this would have required them to reconsider the status quo in development processes [42]. Policies that adopt bottom-up approaches should then directly stem from the needs of the people living in a certain context, rather than from those of policy-makers in the upper part of the political hierarchy, who may not be fully aware of how their policies could go on to concretely impact people's lives.

Through the means of the same mechanism of inclusivity that has enabled indigenous leaders to be appointed at the head of governmental offices, indigenous representatives have also been forced to comply with state institutions and restrain their more radical demands, otherwise running the risk of being strongly criticised or even criminalised by the state [16], resulting in a problematisation of power relations between different political actors and in governmental control of social movements, a silencing of critical political voices [16].

An even bigger issue can be identified: the BV framework in Bolivia currently coexists with the Western mainstream developmental perspective, which simultaneously allows for the extractive exploitation (mainly mining, oil, and gas) of indigenous and Amazon territories apparently "on behalf of the national interest", therefore resulting in "state dispossession of territories and livelihoods" and a "profound economic dependence on natural resource exploitation," despite many articles of the Bolivian Constitution asserting the country's need to move away from such destructive practices (articles 1, 2, 290, 316, 319) [25]. Since the state has

complete ownership of natural resources, indigenous groups, who tend to perceive the territories they live in as inalienable, are not asked to provide their consent before the State engages in practices that are destructive to their environment and harmful to their people [25]. The indigenous peoples' right to consultation and to be informed, as Flemmer and Schilling-Vacaflor argue [42], should represent "the basis of the new global model shaping state-indigenous relations," as it enables indigenous people to play an active part in their own development, especially when it concerns significant socio-environmental impacts on their lands.

At this point, a parallel can be drawn between the South American indigenous perspective on nature and Barry Commoner's Law 1 and Law 4 of ecology which, respectively, assert that "Everything is Connected to Everything Else" and "There Is No Such Thing as a Free Lunch" [28]. The indigenous experience in South America is, indeed, deeply linked to conceiving nature as a living, sentient being, which should not be treated as a commodity for exploitation [17]; it is a whole, comprehensive system that is deeply associated with human activities (be they preservative or destructive), and it is cherished as an ensemble of elements to utilise and recycle in a respectful way (since nothing in nature can be regarded as a "free lunch" and everything comes with a consequence) that allow human populations to grow and flourish.

Despite BV's "radical critique of the foundations of the idea of development" arguably going as far as to represent not an "alternative to development" but an "alternative to alternative development" [25], it seems that the mainstream economic model has not yet been challenged in Bolivia, maybe on account of BV's assimilation into Western developmental frameworks. BV's transformative potential has been vanishing in the process of translation into concrete political practices, a process that poses a great risk to these indigenous beliefs' so-called "indigeneness" [2]. There are still several contradictions and inconsistencies between official pronouncements regarding the indigenous cause and environmental protection and actual exploitative governmental practices [16].

Before concluding, and after having explained the complex social, political, economic, and environmental challenges that the policies of GNH and BV seem to pose, we would like to relate all of the aforesaid to a useful tool for systematically assessing any sort of system in a methodological and thorough fashion, namely the systemic thinking iceberg (**Figure 4**), which breaks down any system into sections on the basis of their "depth" or, rather, the increasing leverage that would result in acting on certain factors of the system in question. Such a tool can also be taken into account in relation to any environmental policy for analysing whether it'd be possible to operationalise said policy to a context different than that of origin, especially for what concerns the underwater tip of the iceberg, which consists in identifying the values, assumptions, and beliefs that intrinsically shape the system and make it what it is. Thus, advancing an open question, would identifying such variables for the policies of GNH and BV give insight into how to harness their potential in countries other than those of origin? And if so, in what fashion could such research be carried out in order for it to be as objective and unbiased as possible? What concerns the intrinsic cultural views and beliefs of researchers?

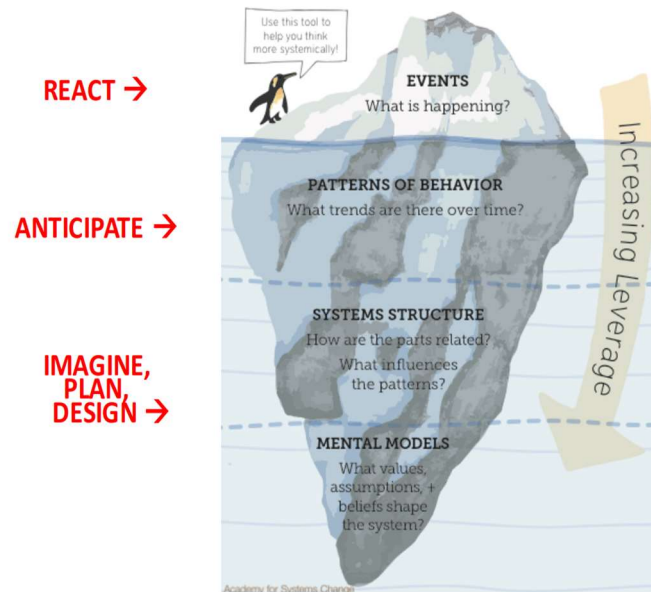


Figure 4. Systemic thinking iceberg.

Source: own additions (in red on the left) to the original image of Academy for Systems Change (1996). The Iceberg model [43].

5. Conclusion

As all the above points have demonstrated, nowadays more than ever, there is a concrete need for the Global South to influence the North in terms of how development might be envisioned in the future, moving away from unsustainable practices solely focused on GDP and towards more holistic views of wellbeing and growth. More and more Global Southern countries are starting to transcend the North-South dichotomy and reshape the definition of development through their own distinctive societal and environmental paradigms on change, growth, and betterment, ultimately aiming to build more sustainable and inclusive futures for themselves while setting the example for other nations to follow. Nevertheless, the dominant GDP-based approach to development is still reluctant to welcome a new set of metrics able to merge knowledge coming from several aspects of sustainability, societies, and collective well-being with mainstream development worldviews. Further research in such a complex field is needed in order to better comprehend how the Western canon in innovation thinking could be decentered so as to make space for alternative epistemological perspectives that are better aligned with environmental and social concerns than the ones currently being employed, in such as the above-explained policies of Gross National Happiness and Buen Vivir. Ideally speaking, the key question should be more “How can the state engage with indigenous and traditional knowledge and redefine itself according to it?” rather than how to assimilate such knowledge and maintain the primacy of economic growth, but this does not reflect the world that we have so far created for ourselves. As with any radical decolonising project that questions the very foundations of Western-type power relations, an increased degree of self-criticism and introspection is needed for the policies of GNH and BV, with an accurate analysis of the implications and challenges that they might bring adopted as the focus of new research on this subject. The most relevant adversity for the time being is to assess the most effective way to successfully operationalise such tools in their countries of origin (especially in

the case of Bolivia, as we have seen) and, eventually, in other countries that might perceive measuring wellbeing and safeguarding the natural environment, as well as the people living in it, as the new development frameworks going forward if humanity is to hope avoiding the looming environmental crisis that is currently threatening not only humankind's extinction but also that of countless other species in the process and a whole planet's ecological balance. All in all, alternative epistemologies from the Global South, such as the two ones discussed in the present manuscript, offer insights into how the very notion of development and wellbeing can be meant and implemented in both the Global South and the Global North, within a wider understanding of decolonial thinking, i.e., not only an economic one but also philosophical and political.

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References

1. Harari YN. *Homo Deus: A Brief History of Tomorrow*. Random House; 2016.
2. Kothari A, Salleh A, Escobar A, et al. *Pluriverse: A Post-Development Dictionary*. Tulika Books and Authorsupfront; 2019.
3. Ahmed Y. Political discourse analysis: a decolonial approach. *Critical Discourse Studies*. 2020, 18(1): 139-155. doi: 10.1080/17405904.2020.1755707
4. Bifulco L, Borghi V. Public sociology, a perspective on the move. In: Bifulco L, Borghi V (editors). *Research Handbook on Public Sociology*. Edward Elgar Publishing; 2023. pp. 2–18. doi: 10.4337/9781800377387.00007
5. Tarocco F. The Buddhist Economies of Modern Urban China. *Hualin International Journal of Buddhist Studies*. 2019, 2(2): 250-272. doi: 10.15239/hijbs.02.02.09
6. Paulson S, Gezon LL, Watts M. Locating the Political in Political Ecology: An Introduction. *Human Organization*. 2003, 62(3): 205-217. doi: 10.17730/humo.62.3.e5xcjnd6y8v09n6b
7. Robbins P. *Political Ecology: A Critical Introduction*. John Wiley & Sons; 2019.
8. Worldometer. Countries in the world by population. Available online: <https://www.worldometers.info/world-population/population-by-country/> (accessed on 2 December 2023).
9. Lepeley MT. Bhutan's gross national happiness: An approach to human centred sustainable development. *South Asian Journal of Human Resources Management*. 2017, 4(2): 174-184. doi: 10.1177/23220937177316
10. Solarz MW, Wojtaszczyk M. Are the LDCs really the world's least developed countries? *Third World Quarterly*. 2016, 38(4): 805-821. doi: 10.1080/01436597.2016.1241138
11. Verma R. Gross National Happiness: meaning, measure and degrowth in a living development alternative. *Journal of Political Ecology*. 2017, 24(1). doi: 10.2458/v24i1.20885
12. TED. This country isn't just carbon neutral—it's carbon negative. Available online: https://www.youtube.com/watch?v=7Lc_dIVrg5M&t=471s&ab_channel=TED (accessed on 2 December 2023).
13. Tideman SG. Gross National Happiness: lessons for sustainability leadership. *South Asian Journal of Global Business Research*. 2016, 5(2): 190-213. doi: 10.1108/sajgbr-12-2014-0096
14. Bates W. Gross national happiness. *Asian-Pacific Economic Literature*. 2009, 23(2): 1-16. doi: 10.1111/j.1467-8411.2009.01235.x
15. Daga G. Towards a new development paradigm: Critical analysis of gross national happiness. Available online: https://d1wqtxts1xzle7.cloudfront.net/33743091/Critical_Analysis_of_Gross_National_Happiness_Index_libre.pdf?1400563868=&response-content-disposition=inline%3B+filename%3DTowards_a_New_Development_Paradigm_Criti.pdf&Expires=1708570034&Signature=CTJhsRmh~4xRUOQVP1DfbtmOecxCaYSAgT9PMQQXkJfRuucksm~w5XWtm-WAWb2NgbOkf~hfom8z5HAs5Afsc45saTfQ2~2FG2RbzrICEvpEjxDYC-L~R3E4umgLjJcL509~8ZASow0uJgEJEGV2NnNaiSM3ZvaagWk~VjrDTzZK0kzsncHcViOb3k9uR58dN10VTjwL1JOaXxJLAI~vDFrYoRuASv0y0ixgvlMrLOU2sRtUUmoKRbBZdORpg46WuH667gqwylzAsuE55ZAUJDLT2KtrLD9iXkedcUh

- YM-2yCKDnEEIB7obQAXpdWA~114zv-NYCFmJl1i4eBI5HMA__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA (accessed on 22 February 2024).
16. Ranta EM. Toward a Decolonial Alternative to Development? The Emergence and Shortcomings of Vivir Bienas State Policy in Bolivia in the Era of Globalization. *Globalizations*. 2016, 13(4): 425-439. doi: 10.1080/14747731.2016.1141596
17. Jimenez A, Delgado D, Merino R, et al. A Decolonial Approach to Innovation? Building Paths Towards Buen Vivir. *The Journal of Development Studies*. 2022, 58(9): 1633-1650. doi: 10.1080/00220388.2022.2043281
18. Chassagne N. Sustaining the ‘Good Life’: Buen Vivir as an alternative to sustainable development. *Community Development Journal*. 2018, 54(3): 482-500. doi: 10.1093/cdj/bsx062
19. Gudynas E. Buen Vivir: Today’s tomorrow. *Development*. 2011, 54(4): 441-447. doi: 10.1057/dev.2011.86
20. Acosta A. Living Well: ideas for reinventing the future. *Third World Quarterly*. 2017, 38(12): 2600-2616. doi: 10.1080/01436597.2017.1375379
21. van Norren DE. The Sustainable Development Goals viewed through Gross National Happiness, Ubuntu, and Buen Vivir. *International Environmental Agreements: Politics, Law and Economics*. 2020, 20(3): 431-458. doi: 10.1007/s10784-020-09487-3.
22. Ura K, Alkire S, Zangmo T, et al. A Short Guide to Gross National Happiness Index. The Centre for Bhutan Studies; 2012. doi: 10.35648/20.500.12413/11781/ii025
23. Ura K, Alkire S, Zangmo T, et al. An Extensive Analysis of GNH Index. Heidelberg University Library; 2013. doi: 10.11588/XAREP.00002733
24. Easterlin RA, O’Connor KJ. The Easterlin paradox. In: Zimmermann KF (editor). *Handbook of labor, human resources and population economics*. Springer International Publishing; 2022. pp. 1–25. doi: 10.1007/978-3-319-57365-6_184-2
25. Merino R. An alternative to ‘alternative development’? Buen vivir and human development in Andean countries. *Oxford Development Studies*. 2016, 44(3): 271-286. doi: 10.1080/13600818.2016.1144733
26. Cappelli F, Caravaggio N, Vaquero-Piñeiro C. Buen Vivir and forest conservation in Bolivia: False promises or effective change? *Forest Policy and Economics*. 2022, 137: 102695. doi: 10.1016/j.forpol.2022.102695
27. Kuhn TS. *The structure of scientific revolutions*. University of Chicago Press; 1962.
28. Commoner B. *The Closing Circle. Nature, Man, and Technology*; 1971.
29. Meadows DH. *Thinking in systems: A Primer*. Chelsea Green Publishing; 2008.
30. Brooks JS. Avoiding the limits to growth: Gross National Happiness in Bhutan as a model for sustainable development. *Sustainability*. 2013, 5(9): 3640-3664. doi: 10.1111/j.1467-8411.2009.01235.x
31. Munslow B, O’Dempsey T. Globalisation and Climate Change in Asia: the urban health impact. *Third World Quarterly*. 2010, 31(8): 1339–1356. doi: 10.1080/01436597.2010.541082
32. Meadows D, Randers J, Meadows D. *Limits to Growth. The 30-Year Update*. Earthscan; 2005.
33. Siani E. Buddhism and power. In: Chachavalpongpun P (editor). *Routledge Handbook of Contemporary Thailand*. Routledge; 2019. pp. 268–277. doi: 10.4324/9781315151328
34. Grugel J, Uhlin A. Renewing Global Governance: demanding rights and justice in the global South. *Third World Quarterly*. 2012, 33(9): 1703-1718. doi: 10.1080/01436597.2012.721234
35. Kamei M, Wangmo T, Leibowicz BD, et al. Urbanization, carbon neutrality, and Gross National Happiness: Sustainable development pathways for Bhutan. *Cities*. 2021, 111: 102972. doi: 10.1016/j.cities.2020.102972
36. Lang M. Buen Vivir as a territorial practice. Building a more just and sustainable life through interculturality. *Sustainability Science*. 2022, 17(4): 1287-1299. doi: 10.1007/s11625-022-01130-1
37. Villalba U. Buen Vivir vs Development: a paradigm shift in the Andes? *Third World Quarterly*. 2013, 34(8): 1427-1442. doi: 10.1080/01436597.2013.831594
38. Roy P. Economic growth, the UN and the Global South: an unfulfilled promise. *Third World Quarterly*. 2016, 37(7): 1284-1297. doi: 10.1080/01436597.2016.1154440
39. Gray K, Gills BK. South–South cooperation and the rise of the Global South. *Third World Quarterly*. 2016, 37(4): 557-574. doi: 10.1080/01436597.2015.1128817
40. Fuhr H. The rise of the Global South and the rise in carbon emissions. *Third World Quarterly*. 2021, 42(11): 2724-2746. doi: 10.1080/01436597.2021.1954901
41. Douglas H. Science, values, and citizens. In: Adams M, Biener Z, Feest U, Sullivan J (editors). *Eppur si muove: Doing History and Philosophy of Science with Peter Machamer*. Springer; 2017. doi: 10.1007/978-3-319-52768-0_6

42. Flemmer R, Schilling-Vacaflor A. Unfulfilled promises of the consultation approach: the limits to effective indigenous participation in Bolivia's and Peru's extractive industries. *Third World Quarterly*. 2015, 37(1): 172-188. doi: 10.1080/01436597.2015.1092867
43. The Donella Meadows Project. Systems thinking resources. Available online: <https://donellameadows.org/systems-thinking-resources/> (accessed on 2 December 2023).
44. Keeble BR. The Brundtland report: 'Our common future.' *Medicine and War*. 1988, 4(1): 17-25. doi: 10.1080/07488008808408783

Commentary

Education for sustainable development in art, science, technology, and the environment: Is there a methodological proposal for school and higher education?

Diego BernaschinaIndependent Researcher, Santiago 8320000, Chile; diego_artista@yahoo.es**CITATION**

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Abstract: This article aims to examine the relationship between art, science, technology, and the environment to transform the vitality of developing methodological strategies through education for sustainable development. The main goal is to generate a greater importance of a new demand through the selective didactic proposal in different educational systems, both for school education and for higher education. The new methodological foundations for rethinking and reviewing the knowledge of educational research through documentary study and sustainability in the general educational system. This model of sustainable development in education—schooling and higher education—involves actions and activities based on the concept of sustainable development. There is a new search for different modalities and educational subjects for sustainable development. The new methodological orientation in both educational systems makes it possible to create teaching tools that address sustainability, tolerance, and self-care responsibility toward the future of climate change.

Keywords: school education; higher education; art; science; technology; environmental; sustainability; holistic approach

1. Introduction

The sensitivity of the research has led many authors to consider nature as living beings and environmental communication, especially learning tools and teaching materials, taking into account that transforming sustainability education is related to holistic-philosophical theory, that is, creating new multidisciplinary knowledge for environmental culture, technology, biology, art, and science [1–6]. Education for Sustainable Development (ESD) is a learning approach to foster different attitudes and values, incorporating a sustainable and equitable future for all schools and higher education, depending on the educational system [7,8]. Also, there is a need in the ESD literature to include the holistic approach, since it represents multiple perspectives on the content of environmental, social, and economic factors, depending on the interrelationship between space and time [9–11]. However, it is possible to learn a new holistic approach to ESD. The great challenge facing our planet is quite urgent and very dramatic. According to the current definition of Global Goal No. 4 for Sustainable Development Goals (SDGs) [12], ESD is contemplating its goal of “ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all” [13]. Therefore, this global goal 4 for the SDGs requires a transformative approach to education that goes beyond literacy and sustainability. Not all emphasis should be on the quality of nature, but it envisions an inclusive education system that ensures equality of access for marginalized and impactful student groups. The idea of school and higher education underlies the competence of ESD for students through a series

of holistic, interdisciplinary content perspectives and democratic education strategies [9].

Most of the educational activities of human beings have altered the Earth's ecosystems in such a way that our very survival seems to be in danger due to new changes that are increasingly difficult to reverse. Instead, this means comprehensively addressing environmental, social, and economic problems before global warming increases to several dangerous levels and new climate change finds, deepening with eco-philosophy, such as the holistic approach and ethic systems. UNESCO's Education for Sustainable Development 2030 initiative aims to achieve the personal and social changes necessary to turn the new curriculum and teaching materials, especially the incorporation of students and teachers [14,15]. It becomes necessary to identify the abilities of "the weakest" to enhance his abilities within the class group; the consequent educational proposal will have to respond to the needs of pupils, taking into account the conditions of the extreme heterogeneity of the classes and aiming at the discovery of their bodies and their motor and communication skills to increase esteem and self-confidence [16,17]. It is difficult to judge the ESD in relation to the study of the holistic approach to the subject and the pluralistic approach to teaching in relation to the sustainability awareness of the students and, of course, the educational system [9]. The necessity arises to identify the strengths and abilities of those considered the most vulnerable within the class group. Subsequently, the educational proposal should cater to the diverse needs of students, taking into account the considerable heterogeneity within the classes. It is to explore and develop their physical, motor, and communication skills, fostering an environment that enhances self-esteem and confidence.

The main goal is to generate a greater importance of a new demand through the selective didactic proposal in different educational systems, both for school education and for higher education.

2. Materials and methods

The systematic approach employs teaching materials development and adaptation, incorporating diverse and complementary subjects like bioart, environmental art technology, recycled art, and other related areas. This approach applies teacher training and educational practices across various levels of universal education.

The new methodological foundations to rethink and review the knowledge of educational research through documentary study and sustainability in the general educational system. Likewise, the research used in the literature study to deepen the various characteristics depending on the educational analyses, both for school education and for higher education, but not all sources were provided for different studies; also, some sources were collected, compared, and analyzed according to the SDGs of qualitative research. These initiatives seek institution-wide curricular change to recognize overlaps between ESD and other thematic agendas, such as interdisciplinary teaching and learning, graduate employability, and citizenship education [18].

3. Results

This model of sustainable development of education—schooling and higher education—involves actions and activities based on the concept of sustainable development. Therefore, this complexity of the SDGs system generates teaching quality and transversal educational learning through sustainable development along with activities based on art, science, technology, and the environment.

When discussing sustainable development, it is considered that sustainability has three dimensions: the environment, the economy, and society (**Figure 1**); therefore, the main idea revolves around achieving a good balance, expressed using other commonly used terms such as pillars, domains, aspects, and spheres [19]. Finally, several authors have discussed the three dimensions of sustainability to classify planetary (or ecological) integrity, transforming the other term into an environmental dimension [20,21].

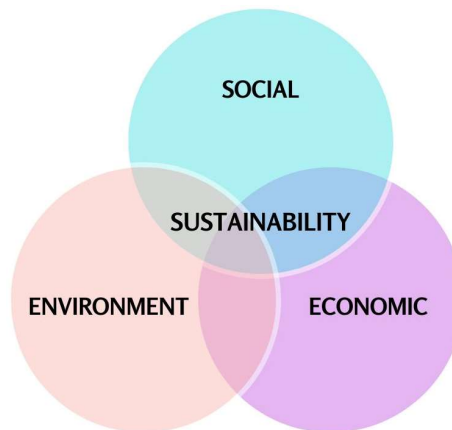


Figure 1. Three dimensions of the original model [19].

This visual representation shows sustainability as three circles that intersect their three dimensions to intervene in the new concept related to the methodological proposal in different educational systems, depending on the level of student learning or the teaching of professional teachers. Next, there are several representations between art, science, technology, and the environment to transform the selective didactic proposal in different educational systems (**Figure 2**).

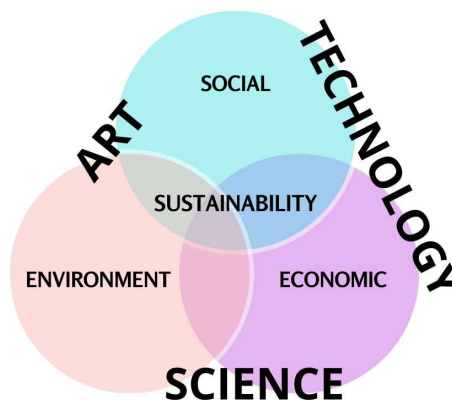


Figure 2. Additional three areas along with the three dimensions of the original model [19].

It is hard to analyze ESD based on the new meanings or the different educational branches together with the three long-term dimensions, or the major priority changes, that is, depending on the SDGs through educational modalities and subjects for sustainable development. Both figures are parts of the innovative proposal through a holistic approach and educational ethics, depending on the teaching role and its establishments/institutions within the contents of didactic material or different programs of the complementary subject.

4. Discussion

There is a new search for different modalities and educational subjects for sustainable development. For example, some ESD keys are included in various educational subjects to optimize sustainable development and, of course, the improving use of didactic tools throughout the universal education system (**Table 1**).

Table 1. Keys of ESD about the methodological proposal for school and higher education.

Key	Description	Parameter based on SDGs
Artful awareness for sustainable development	Within the framework of ESD, a significant goal is to cultivate a nuanced understanding and appreciation for sustainable development issues through artistic expression. This encompasses themes such as climate change, biodiversity loss, poverty, and social inequality, aligning with UNESCO's SDGs.	(1), (2), (3), (5), (6), (7), (8), (9), (10), (11), (12), (13), (14), (15)
Holistic critical thinking	ESD encourages a holistic approach to critical thinking, urging learners to analyze intricate global challenges with depth and insight. This involves exploring the intricate interconnections between social, economic, and environmental factors within the realms of art, science, and technology, in line with UNESCO's SDGs.	(1), (5), (6), (7), (8), (9), (10), (11), (12), (13), (14), (15), (16), (17)
Interdisciplinary fusion for comprehensive solutions	ESD champions interdisciplinary approaches that seamlessly integrate insights and perspectives from various disciplines, including art, science, technology, and environmental studies. This approach is essential for developing comprehensive and sustainable solutions in alignment with UNESCO's SDGs.	All, and except of (4)
Artistic civic engagement for positive impact	ESD seeks to empower individuals through artistic expression, enabling active civic engagement in communities. By merging art and science, individuals can contribute meaningfully to positive social and environmental change, aligning with UNESCO's SDGs.	All, and except of (4)
Ethical foundations in art, science, and environment	ESD places a strong emphasis on ethical values, including social responsibility and environmental stewardship, instilling a sense of duty toward present and future generations. This ethical framework is integral to UNESCO's SDGs.	(1), (3), (5), (6), (7), (8), (9), (10), (11), (12), (13), (14), (17)
Integrated skills development for sustainability	ESD focuses on cultivating practical skills within the intersection of art, science, and technology. This includes critical thinking, problem-solving, collaboration, and communication skills, all crucial for addressing sustainability challenges in alignment with UNESCO's SDGs.	All, and except of (4)
Artful promotion of sustainable lifestyles and choices:	Through the integration of art, science, and environmental ethics, ESD encourages individuals to adopt sustainable behaviors and lifestyles. This involves considering the environmental, social, and economic impacts of their choices, contributing to the realization of UNESCO's SDGs.	All, and except of (4)

Note: SDGs do not correspond to the listing of 17 goals with their targets and indicators about the key and the description: (1) = No poverty; (2) = Zero hunger; (3) = Good health and well-being; (4) = Quality education; (5) = Gender equality; (6) = Clean water and sanitation; (7) = Affordable and clean energy; (8) = Decent work and economic growth; (9) = Industry, Innovation and Infrastructure; (10) = Reduced inequality; (11) = Sustainable cities and communities; (12) = Responsible consumption and production; (13) = Climate action; (14) = Life below water; (15) = Life on land; (16) = Peace, justice and strong institutions; (17) = Partnership for the goals [7,8,12].

However, some points to contextualize the preparatory skills, as well as this table, incorporate the objective (SDG 4) associated with ESD into several goals for 2030. It is not easy to create a new methodological proposal for students, depending on the educational system of school and higher education. Through the creation of inclusive

teachings in various branches or didactic knowledge towards the future of the SDGs, it is possible to propose free, equitable, and sustainable quality education to produce and motivate independent and relevant learning. It is possible to ensure that the entire educational system, of course, including school and higher education students, have various personalized access—similar to the Finnish educational system—for teaching.

The question is not so much whether these are the key concepts; rather, they provide a starting point for developing interpretations within the disciplines of environmental, functional, cultural, and critical literacy [22]. However, the current situation of equal access through sustainable culture in the universal educational system to transform art, environmental, technological literacy, and scientific/experimental study, depending on school and higher education, and including education in general. Not all the skills necessary to access the educational project and teaching work are limited to specific levels, but all levels of teaching and vocational training are for vulnerable people, including people with disabilities, sexual orientations (or diversity), women, indigenous peoples, and economically disadvantaged people. This inclusion is not achieved through social reinforcement integrated into the methodological proposals of various educational areas for sustainable development.

5. Conclusion

There is no search for holism in complementary education for sustainable development within the educational system. The new methodological orientation in both educational systems makes it possible to create teaching tools that address sustainability, tolerance, and self-care responsibility toward the future of climate change. With this complexity of the educational interaction of the SDGs, it is essential to analyze the alternative quality, that is, the educational practice is connected with the role of teaching to facilitate student learning, of course, the study plan on the knowledge of various disciplines, classroom management and guidance to solve problems and sustainable development, and of course, professional ethics within the universal educational system.

It is relevant to value teaching motivation and the connection between environmental culture, technology, biology, art, and science with the didactic tools used. It is not always possible to determine new criteria for different knowledge (or new concepts) in school and higher education to enrich students at various levels of learning.

Finally, to highlight the new debate through UNESCO's SDGs that prevents educational work through the set of creative-experimental practices that relate art, science, technology, and, of course, the crisis of climate change to support the environment. On the other hand, our methodology aims to use new teaching instruments to improve literacy and sustainability for school and higher education within ESD.

Conflict of interest: The author declares no conflict of interest.

References

1. Stein S, Andreotti V, Suša R, et al. From “education for sustainable development” to “education for the end of the world as we know it.” *Educational Philosophy and Theory*. 2020, 54(3): 274-287. doi: 10.1080/00131857.2020.1835646
2. Baumber A. Transforming sustainability education through transdisciplinary practice. *Environment, Development and Sustainability*. 2021, 24(6): 7622-7639. doi: 10.1007/s10668-021-01731-3
3. Montuori A. Integrative Transdisciplinarity. *Transdisciplinary Journal of Engineering & Science*. 2022, 13. doi: 10.22545/2022/00209
4. Brown GTL. The past, present and future of educational assessment: A transdisciplinary perspective. *Frontiers in Education*. 2022, 7. doi: 10.3389/educ.2022.1060633
5. Stubrin LH. Art and Science: Convergence in the Framework of Complexity Theory. *Artnodes*. 2013, 13. doi: 10.7238/a.v0i13.1485
6. Bernaschina D. Bioart for education: Methodological proposal for school and university education (Spanish). *Tercio Creciente*. 2023, 7: 123-142. doi: 10.17561/rtc.extra7.7069
7. UNESCO. What you need to know about education for sustainable development. Available online: <https://www.unesco.org/en/education-sustainable-development/need-know> (accessed on 16 December 2023).
8. UNESCO. Education for sustainable development. Available online: <https://www.unesco.org/en/sustainable-development/education> (accessed on 16 December 2023).
9. Boeve-de Pauw J, Gericke N, Olsson D, Berglund T. The Effectiveness of Education for Sustainable Development. *Sustainability* 2015, 7(11): 15693-15717. doi: 10.3390/su71115693
10. Gough S. Right answers or wrong problems? Towards a theory of change for environmental learning. Available online: <https://trumpeter.athabascau.ca/index.php/trumpet/article/view/122/132> (accessed on 23 January 2024).
11. Summers M, Childs A. Student science teachers’ conceptions of sustainable development: an empirical study of three postgraduate training cohorts. *Research in Science & Technological Education*. 2007, 25(3): 307-327. doi: 10.1080/02635140701535067
12. UNESCO. The 17 Goals. Available online: <https://sdgs.un.org/goals> (accessed on 16 December 2023).
13. UNESCO. The Goal 4. Available online: <https://sdgs.un.org/goals/goal4> (accessed on 16 December 2023).
14. Shava GN, Mkwelie N, Ndlovu MJ, et al. Higher Education Institutions’ Sustainable Development towards Agenda 2030: A Global Goals in Policy and Curriculum. *International Journal of Research and Innovation in Social Science*. 2023, 7(4): 1320-1336. doi: 10.47772/ijriss.2023.7510
15. Oe H, Yamaoka Y, Ochiai H. A Qualitative Assessment of Community Learning Initiatives for Environmental Awareness and Behaviour Change: Applying UNESCO Education for Sustainable Development (ESD) Framework. *International Journal of Environmental Research and Public Health*. 2022, 19(6): 3528. doi: 10.3390/ijerph19063528
16. Latino F. The school-family alliance to create inclusive prescriptions: Physical education as a means of empowerment for educational and training strategies. *Italian Journal of Health Education, Sports and Inclusive Didactics*. 2022, 6(2). doi: 10.32043/gsd.v6i2.641
17. Vargas-Hernández JG, Tovar Vergara M. Didactic strategies for meaningful learning. In: Saura JR (editor). *Teaching Innovation in University Education: Case Studies and Main Practices*; IGI Global; 2022. pp. 33-51. doi: 10.4018/978-1-6684-4441-2.ch003
18. Ryan A. Education for sustainable development and holistic curriculum change: A review and guide. Available online: https://s3.eu-west-2.amazonaws.com/assets.creode.advancehe-document-manager/documents/hea/private/esd_artwork_050412_1324_1568036703.pdf (accessed on 23 January 2024).
19. Purvis B, Mao Y, Robinson D. Three pillars of sustainability: in search of conceptual origins. *Sustainability Science*. 2018, 14(3): 681-695. doi: 10.1007/s11625-018-0627-5
20. Kotzé LJ, Kim RE, Burdon P, et al. Planetary integrity. In: Sénit CA, Biermann F, Hickmann T (editors). *The Political Impact of the Sustainable Development Goals: Transforming Governance Through Global Goals?* Cambridge University Press; 2022. pp. 140-171. doi: 10.1017/9781009082945.007
21. Bosselmann K. Losing the Forest for the Trees: Environmental Reductionism in the Law. *Sustainability*. 2010, 2(8): 2424-2448. doi: 10.3390/su2082424
22. Stables A, Scott W. The Quest for Holism in Education for Sustainable Development. *Environmental Education Research*. 2002, 8(1): 53-60. doi: 10.1080/13504620120109655

Review

Supply chain sustainability initiatives at Bajaj Electricals Limited to achieve Zero Waste to Landfill

Anita Kumar^{1,2}¹ University of South Wales, CF37 1DL Treforest, United Kingdom; anita.kumar@ciisl.amity.edu² CII School of Logistics, Amity University Uttar Pradesh, Noida 201313, India**CITATION**

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Abstract: Subject area: This case allows management students to engage with the implementation of sustainable supply chain management practices both at the macro and micro levels. The decision to make supply chain operations sustainable is no longer an option for many organisations. The question is not “should we do it? but how can we implement sustainable supply chain management practices?” **Study level/applicability:** This case has been developed for management institutes and schools that teach undergraduate and postgraduate programmes. Sustainability has become an essential module in management curriculums; thus, this case is relevant for management programmes (operations, logistics, supply chain management, business studies, and management). **Case overview:** This case highlights the achievements of Rameshwaram (plant head at the Nirlep factory of Bajaj Electrical Ltd.) and his team for successfully completing a sustainability initiative—Zero Waste to Landfill (ZWTL)—in a short span of six months. This case is divided into two parts: the first part presents their initiatives in making all echelons of their supply chain sustainable; the second part specifically outlines how they achieved Zero Waste to Landfill in one of the manufacturing operations in a short span of six months. A cross-functional team was put together to plan and implement the ZWTL project. Initially, the team encountered many challenges, such as poor quantification of waste at the factory site, inadequate infrastructure for waste segregation, a lack of vendor participation, and extensive training of vendors and employees as needed to ensure project compliance. However, with sustained efforts, the goal was achieved. As a result, BEL became the first Indian company in the sector to achieve 99% diversion from landfills for the waste generated at the Nirlep factory in 2021. It translated into a dramatic reduction of adverse environmental impacts. Monetary benefits were also realized by utilizing the waste for commercial use. As customers across the globe appreciated their efforts, their brand equity increased severalfold. **Expected learning outcomes:** The case establishes that supply chain sustainability initiatives can never be completely successful without the unanimous engagement of internal and external stakeholders. In present times, the foundation of business performance has moved away from financial profitability only to the “triple bottom line,” which incorporates environment and social responsibility. The choice between commercial viability and sustainability is no longer available to the companies, as they need to integrate environmental and social goals within their businesses and provide transparency on sustainable performance and value to not only all stakeholders but also policymakers and consumers.

Keywords: supply chain sustainability; Zero Waste to Landfill; 5R approach

1. Introduction

Supply chain sustainability has been a critical topic of discussion amongst academics and practitioners for almost two decades now, more so after the COVID-19 pandemic. As modern supply chains become global, their environmental footprints

become more visible as goods are produced, transported, and consumed across the globe. Supply chain sustainability refers to the companies' initiatives to integrate and manage the environmental and social impact of their products' movement through the supply chain, from raw material suppliers to production, storage, and delivery to the final customer [1]. Consequently, supply chain managers shoulder added responsibilities that include decision-making on sustainable sourcing, zero waste management at manufacturing sites, relationship management with recyclers, and asset recovery, in order to cut down costs and maximise sustainability-related efforts [2]. Although financial profitability and growth still remain the focus for most organisations, the goal to minimize environmental damage through the reduction of energy and water consumption and waste production while creating a positive influence on people and communities is now embedded in the triple bottom line [3].

In response to the wake-up call given globally by various stakeholders to preserve the environment, many Indian organisations are making substantial efforts to reduce their carbon footprints and enhance sustainability goals. This case chronicles the steps taken at Bajaj Electrical Limited (BEL) to make its supply chain sustainable in a broader context. At a granular level, it showcases the successful implementation of a project—Zero Waste to Landfill (ZWTL)—undertaken at one of the manufacturing sites in a very short span of 6 months. Several challenges were overcome to make this project a success by Rameshwaram—Plant Head and his team in June 2021.

The case demonstrates that organizations can change leaders with the help of dedicated teams to create a difference for people, profits, and planets. Often, it is argued that sustainability initiatives come at the expense of profitability, but this case successfully validates that sustainability goals add to the profitable bottom line. The triple bottom line is a business concept that posits firms should commit to measuring their social and environmental impact—in addition to their financial performance—rather than solely focusing on generating profit, or the standard “bottom line.” It can be broken down into “three Ps”: profit, people, and the planet [4].

Rameshwaram had just started the day's work after sipping hot coffee when he received a call from his boss, Vaibhav Raj—SCM and Manufacturing Head at Bajaj Electricals Limited (BEL). He was being urgently summoned to his office. Rameshwaram knew that his boss had a crucial board meeting with the top management the day before. As he made his way to the boss's office, he started thinking about what had gone wrong in the last few weeks. As the plant head of two manufacturing units of Bajaj Electricals Limited, situated in Aurangabad, Maharashtra, he has worked diligently for the past four years. The worker complaints and machine breakdown—two persistent factory issues—had reduced considerably during his tenure—a fact that he was very proud of.

The boss looked worried when he entered the office. On seeing him, he exclaimed, *“Rameshwaram, we have been selected to lead the Zero Waste to Landfill (ZWFL) initiative by the top management—a goal that we need to achieve in six months. I am happy and proud of the project, but there is no preceding history of its implementation in any Indian organization. There is no predefined protocol, and the time period is very short. I know you have experience and have worked with different teams (operations, marketing, procurement, and new product development), but this is clearly out of our domain. What should we do?”*

After assuring his boss that he would have a preliminary plan in two days, Rameshwaram left his office with mixed feelings—excitement and trepidation—as many thoughts churned in his head. He started recollecting the company’s history as he sat on his chair.

1.1. Bajaj Electricals Ltd. (BEL)—The company background

BEL, a globally renowned and trusted company, was part of INR 380 bn. Bajaj Group. Its business was spread across different categories: 1) illumination—lighting of commercial spaces, industrial premises, infrastructure, and cityscapes with LED lighting, conventional luminaires, accessories, and more; 2) consumer appliances—home and kitchen appliances in the latest designs and technologies; 3) exports—to multiple nations across the globe, ranging from the UAE, Egypt, and Saudi Arabia to Bangladesh, Malaysia, and Indonesia; 4) EPC—the entire spectrum of power transmission, distribution, and illumination. It had its own world-class manufacturing and galvanizing plant. Besides consumer products, the company contributed immensely to outdoor projects such as landscape lighting for Chhatrapati Shivaji terminus, sports lighting for Wankhede, the flag mast at Siachen base camp, and the smart lighting project in Jaipur. With 20 branch offices, 5 in-house manufacturing facilities, approximately 500 customer care centers, and over 3000 employees, the company had a pan-India presence. The company had long-term partnerships with global brands such as Securiton, Switzerland; Delta Controls, Canada; Magnum Energy, USA, etc. The company enjoyed tremendous credibility amongst investors as it had witnessed exponential growth in the share price in the last decade.

1.2. Sustainable development vision at Bajaj Electrical Limited

Rameshwaran recalled that his company was one of the pioneering companies in India to recognize the importance of sustainable development, and hence its vision and mission statement—“enhancing quality of life and bringing happiness with sustainability—included holistic development.” The management had invested in six core values: integrity, teamwork, customer delight, empowerment, innovation, and trust, to ensure a 360-degree buy-in from all stakeholders.

Following the Gandhian principles followed by the founding father, Jamnalal Bajaj, the company is strongly associated with the tagline “preserve the environment, deserve a sustainable future”. Their core business strategy had sustainability embedded in it. The top management believed in giving back to the community, and this was evident by several initiatives they had undertaken in the past few decades (Figure 1).

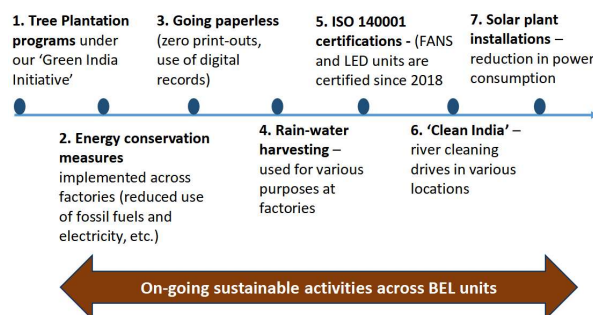


Figure 1. Sustainable activities across BEL units [5].

2. Supply chain sustainability

Rameshwaram had been part of the team that had attended many seminars on supply chain sustainability and led sustainability initiatives at BEL in the past. He had also been part of the newly formed Resilience Group during the COVID-19 pandemic. Although the company was doing well, the management knew that a robust and resilient supply chain was essential for making finished goods available on a timely basis. As with many other companies, BEL also struggled with many challenges due to the COVID-19 pandemic. The company was heavily dependent on the contract manufacturing model for its consumer goods division, and the direct impact was seen in raw material volatility, labour shortages, factory shut-downs, congestion in logistic chains, and restrictions on imports. Indirect impacts such as liquidity crunch, inventory issues, and inadequate supply of subcomponents also posed a serious threat to the smooth recovery.

Rameshwaran's team has undertaken several critical measures to combat these challenges: 1) The 'make vs. buy' analysis for finished goods and critical components, as this aimed to address potential supply shortages and ensure uninterrupted availability of products. 2) 'Alternate supplier development', which helped to expedite capacity augmentation. The initiative focused on revisiting the entire supply ecosystem, covering multiple sub-component suppliers (Tier 2 to Nth), and aiding import localization at a brisk pace via online and offline workshops. 3) 'Project MULYA'—sourcing of commodities was centralised and it offered better controls to support partners in a volatile market. 4) reduction and optimal utilisation of energy, water, raw materials, logistics, etc., by incorporating new techniques and innovative ideas.

a) Sustainable new product development

With the help of the new product development design team, his plant was manufacturing many energy-efficient products, such as Bajaj ceiling fans with anti-germ and dust features, a 5-star-rated fan named 'Kassels Star' that consumed less power as compared to a regular ceiling fan, and a 7-watt LED bulb that delivered as much as 600 lumens more output than a normal 60-watt GLS lamp. Further, none of the Bajaj LED lights used any chemical compounds that were potentially detrimental to the environment. This was in sharp contrast to the CFL, or mercury lamps. The company's range of LED lighting was also safe for domestic usage as it did not emit harmful radiation like ultraviolet light, infrared radiation, or chronic exposure, which caused serious health complications. Also, in view of regular electricity-related issues like power cuts or load shedding that were common in the non-metropolitan regions, the range of Bajaj LED lighting was developed to deal with random voltage fluctuations or abrupt discontinuation of electricity. Last year, Rameshwaran visited the largest Transmission Line Towers (TLT) manufacturing facilities at Ranjangaon in the Pune district of Maharashtra. He had been very impressed as the manufacturing facility was ISO 14000 and ISO 9001 certified and was equipped with the most sophisticated, computer-controlled state-of-the-art machinery. The manufacturing facility had been approved and appreciated by the Power Grid Corporation of India and all reputed electricity boards across the country for its relatively low energy consumption.

b) Sustainable procurement

Rameshwaram also recalled the arguments he had with the Purchase Head, Amit Vohra, last year. He had issued a requisition invoice for raw materials from a new supplier. The new supplier was highly reputed, known for quality and consistency, and innovative in developing eco-friendly raw materials. The supplier had assured Rameshwaram that adequate steps would be taken for safe transportation and optimisation of logistics, which, in turn, helped to mitigate the impact on the climate. In fact, Rameshwaram had been thinking of outsourcing certain key processing activities to this vendor. This would reduce his manufacturing and delivery times to important customers. Although the new vendor had suffered some losses during the COVID-19 pandemic, Rameshwaram had sought approval from the management to support this vendor with technical and financial assistance, which included training for CTQ. All these key initiatives were supported with a “partner-centric approach—a management philosophy that the company had adopted recently wherein the ‘suppliers’ were referred to as ‘partners’ to encourage seamless communication about areas of concern. The company had offered financial help to supply partners and encouraged them to arrange manpower, provide skills training required for the job, and increase shift timings to increase output with limited resources during the COVID-19 pandemic. Financial support was also extended for trade finance and early payments. However, Amit had been against the change of vendor as the new supplier had quoted higher prices (by 15%). After much discussion and negotiation with the new vendor, they sealed the deal, and the new vendor was awarded a contract for 5 years. Amit still reminded him of that tough phase whenever they met for coffee; the contract had been a win-win situation for both the company and the vendor.

c) Sustainable operations

Rameshwaran had been instrumental in adopting technology that remained the bedrock of manufacturing excellence at his plants. Ten years ago, he had been to Germany to receive training on the latest CNC machine for manufacturing home electricals. It had taken almost five years for his team to promote clean energy usage. Rooftop solar panels had been installed at his manufacturing facilities, with an installed capacity of 1.6 MW and the potential to generate ~23 lakh units annually. Almost all consumer products, like water heaters, fans, LED lights, pressure cookers, and mixer grinders, were backed by the latest technology to produce quality products.

His manufacturing facilities faced a tough time when the plants had to be shut down due to the COVID-19 pandemic in March 2020. As the lockdown restrictions eased and manufacturing units started operations again, social distancing protocols were strictly followed. To ensure smooth operations, he has been an integral part of more than six cross-functional teams (CFT) to address key concerns related to productivity, quality, cost optimisation, maintaining adequate inventory levels, increasing operational efficiency, and improving capacity utilisation. Since the workforce was suffering due to ‘no work, no wages’, they had come up with a business continuity plan in July 2020, strictly adhering to COVID-19 protocols that ensured the health and safety of their workers.

d) Sustainable warehouse and transport management

An integral part of manufacturing operations is outbound logistics. Rameshwaram’s workload and stress had reduced considerably when the top

management decided to collaborate with Mahindra Logistics Limited (MLL) to offer innovative logistics optimisation and outsourcing services under ‘Project Samriddhi’. The project involved end-to-end redesigning and outsourcing of logistics services by MLL, with the twin objectives of achieving improved and best-in-class service levels and reducing logistics costs by over 25% annually. It was one of the biggest deals in the Indian logistics industry, worth more than 1000 crore, to be carried out over a period of five years. MLL would completely redesign and consolidate the company’s logistics network with storage optimisation, transportation, and inventory management through the integration of advanced technology and automated processes. MLL was asked to introduce sustainable practices at the warehouses to reduce its impact on the environment. Through the regional fulfilment centres, the goal of improved delivery lead time for pan India customers, dealers, and distributors would be achieved. MLL was also asked to deploy long-haul fleets and local distribution trucks, equipped with the latest tracking technology and set up centralised control towers to ensure smooth operations. MLL promised to eventually use electric delivery trucks from EDel to support Bajaj Electricals’ sustainable logistics practices.

e) Reverse logistics and extended producer responsibility (EPR)

An integral part of Rameshwaran’s job was to provide a safer and more sustainable manufacturing environment. He held regular meetings with his team to ensure that both his plants met the requirements of the E-waste Management Rules, 2016. Since it had become mandatory to recycle or responsibly dispose of electronic and electrical (EEE) waste and follow strict RoHS compliance requirements as per the directives of the Ministry of Environment, Forests & Climate Change (MoEF), his team had been instrumental in implementing reverse logistics through an efficient PAN India network of hubs and regional collection points. This has resulted in the avoidance of unnecessary transportation costs, a reduction in carbon emissions, and an improvement in air quality.

As the lunch hour was announced, Rameshwaram came out of his reverie. He felt confident and proud, and he was sure that he would be able to meet the company’s objectives and expectations, given his background knowledge and expertise. After lunch, he decided to summon his team to his office and set up an action plan.

3. Zero Waste to Landfill (ZWTL)

Linear resource-to-waste systems are unlikely to endure production and consumption practices in the years to come. Zero Waste to Landfill has arisen as a powerful concept that sits at the heart of academic literature from three different streams: sustainable supply chain management, circular economy, and closed loop supply chain management (**Figure 2, Table 1**). The concept has been implemented at multiple levels and with varying degrees of success across the globe. The Zero Waste International Alliance [6] defines zero-waste as “the conservation of all resources through responsible production, consumption, reuse, and recovery of products, packaging, and materials without burning and with no discharges to land, water, or air that threaten the environment or human health.” This grassroots ideology has become an integral part of production policies and consumption patterns at individual and institutional levels. This case is important from a theoretical standpoint, as most Zero

Waste to Landfill projects reported in the academic literature are: a) government-led; b) implemented either at the city or at the country level; c) based in developed countries; and d) have massive allocations of resources. In contrast, the case highlights the successful Zero Waste to Landfill initiative implemented by an organisation from a developing country with limited resources and without any government support.

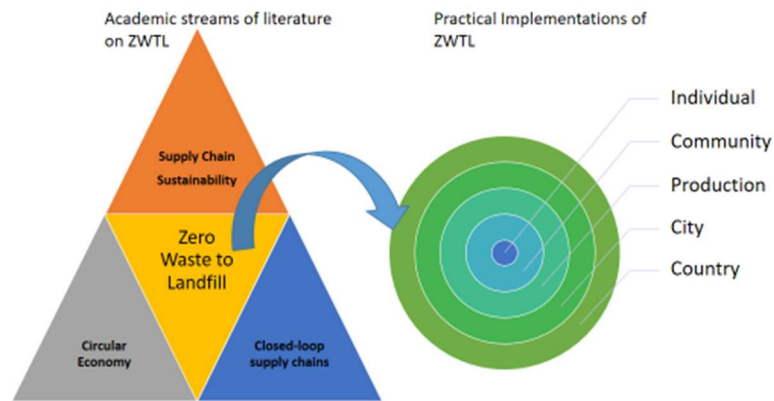


Figure 2. Merging streams of academic literature on Zero Waste to Landfill concept.

Table 1. Key research papers published in the last two decades that can be used for the purpose of theoretical underpinning.

Sustainable supply chain management	Circular economy	Closed loop supply chain management	Zero Waste to Landfill
Seuring and Muller [7]	Geissdoerfer et al. [10]	Guide et al. [12]	Krausz et al. [15]
Carter and Liane Easton [8]	Geng et al. [11]	Kumar and Kumar [13]	Yang [16]
Carter and Rogers [9]		Govindan et al. [14]	Franco-García et al. [17]

In the team meeting after lunch, the following project objectives were formulated.

a) Project objectives

- Institute a robust waste management set-up at BEL factories, ensuring Zero Waste to Landfill with proper waste disposal.
- Follow the 5R philosophy—refuse, reduce, recycle, reuse, remove, and minimize any adverse environmental impact by cutting down waste to landfills.
- Lead by example. Set best practices and standards in the industry for waste management and encourage the ecosystem to work towards zero landfills.

The objectives were to be fulfilled in 6 months (for the Gantt chart, see Appendix **Figure A1**). The following targets were given to the team 1) achieving Zero Waste to Landfill, with a diversion rate exceeding 99%; and 2) continuous reduction in waste for resource conservation and maintaining a sustainable manufacturing process. Rameshwaram, meanwhile, asked his secretary to research ZWTF initiatives implemented in other countries/global organizations.

b) Project team

Although Rameshwaram was leading the project as a project champion, he was required to report to Viabhav, Head of SCM and Manufacturing, supported by the SCM analytics function. Amit and Rajesh Saini (his other plant supervisor) drove the change initiatives at the supplier and factory ends, respectively. Rameshwaram sought

the support of the HR team to conduct extensive training programs for all personnel. The finance team was also brought in to ensure accurate quantification of waste data and supervise changes to be implemented in vendor transactions. A member of the legal team was inducted to ensure all legal compliance and obtain expert input and the required licenses. This cross-functional team (**Figure 3**) agreed to meet weekly and conduct extensive workshops to drive the project. They also agreed to conduct bimonthly reviews to assess progress and re-plan if needed.

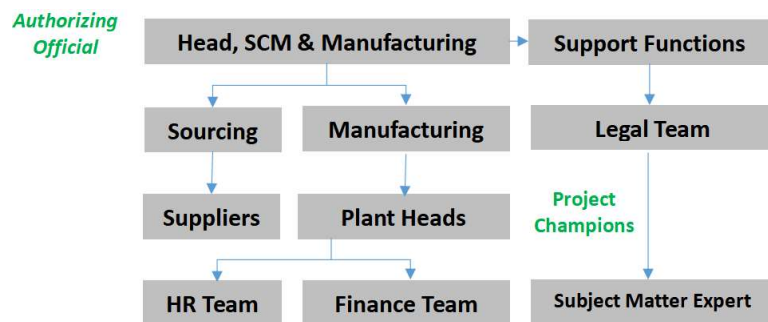


Figure 3. Cross functional team for project implementation.

c) Project planning

Since the manufacturing plant already had a comprehensive SOP as it generated various types of waste (usually disposed of by selling it to scrap dealers and recyclers—70%), a major overhaul was not required. The project was initiated by updating the EHS policy to clearly set out the goal of Zero Waste to Landfill. Communication was sent out to all relevant stakeholders regarding resource planning. The types and quantities of waste generated and the current diversion rate were baselined ‘on an as is, where is’ basis. A gap analysis was carried out to identify the shortcomings. Then, a detailed project plan (**Figure 4**) was chalked out with stringent timelines to reach the desired future state from the current state.

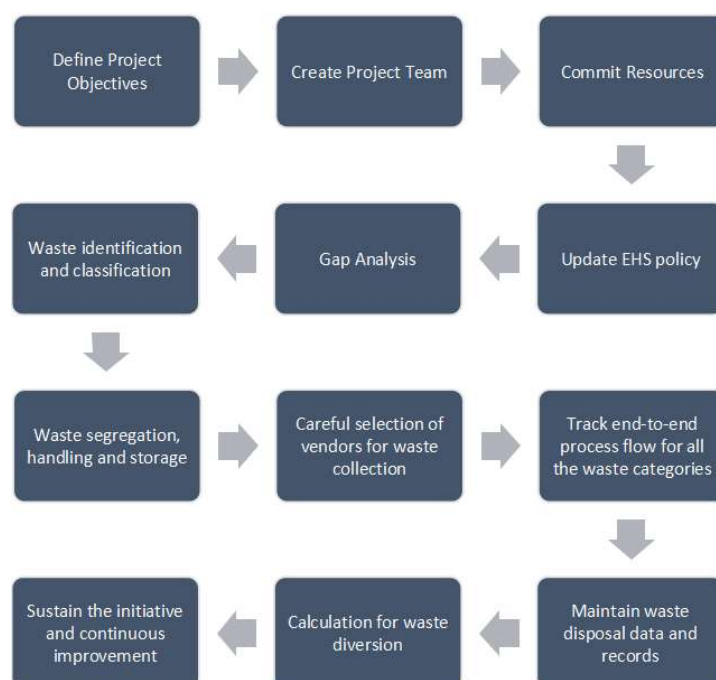


Figure 4. Project plan.

d) Challenges encountered

While working on Week 1 of the project, Rameshwaram and his team members realized the biggest gap was the lack of end-to-end traceability of the waste generated and disposed of. Although 70% of the waste was recycled, there was inadequate identification and quantification of each kind of waste generated at the factory (on the shop floor as well as in office areas). Further, while the workers were well-aware of the defined processes, there was a lack of awareness for proper waste segregation on the floor. Consequently, the waste on the shop floor would sometimes get mixed. The documentation with the waste management vendors also required stringent screening, but when it was conducted, it was found to be incomplete. There was also a lack of visibility on the treatment of non-hazardous waste, especially as waste collectors and government-approved recyclers were ignorant about non-hazardous waste disposal.

e) Investments

Rameshwaram and his team then proposed both financial and nonfinancial investments, which management approved immediately (Appendix **Figure A2**). These investments were made over a period of six months to create infrastructure supporting the waste management system. This included: 1) color-coded waste bins—for segregation of waste at the generation point; 2) waste handling equipment; and 3) a waste storage shed for proper storage of different wastes and providing protection from different weather elements.

More than 40 h of training per month were conducted for all employees and vendors to create awareness regarding the importance of the initiative and help them implement the standard operating procedures. Vendor policy changes were made as the waste disposal was shifted from “through a waste trader to recycler” to “directly to recycler” (with all legal compliances in place).

f) Redressal measures undertaken

Several buyer visits and interviews were carried out to understand the disposal techniques in detail. The legal compliances were researched, and a list of potential vendors who adhered to the legal requirements was made. In one of the meetings, it was decided that a waste management system (WMS) manual covering SOPs and guidelines for various activities would be prepared. The company invested in the necessary infrastructure to ensure the desired WMS manual was circulated in subsequent weeks. It created a documentation procedure that the employees were required to follow strictly. At the supply chain level, it assisted recycling vendors in obtaining all legal documents (such as EHS certificates), and all non-compliant vendors were phased out. The company obtained declarations of waste disposal techniques. A continuous mentorship program was launched for employees and suppliers to bring in a cultural shift to stay dedicated toward a proper waste disposal agenda. Lastly, a stringent 10-point governance program for periodic reviews and audits was established to monitor progress.

- Proper ways of waste identification and classification, segregation, handling, and storage by dedicated teams.
- Suitable vendors for waste—putting together all legal compliances in place
- 100% compliance with the approved process flows.
- Thorough checks of waste disposal data and records.
- Calculation for waste diversion.

- Measures to reduce the waste at the source itself.
- Periodic management reviews and internal audits.
- Extensive training and continuous monitoring of all factory personnel are necessary to ensure correct execution and build a culture of proper waste management across the organization as well as at the supplier end.
- Thorough checks to verify the end treatment of waste, especially in the case of full assistance provided to the vendors while working on the formalities needed to procure the necessary documentation.
- Help from MEPL for a complete understanding of the disposal process and obtaining written confirmation on the correct disposal of hazardous waste.
- Grains.

As the project was completed in July 2021, BEL became the first company in India in the electrical manufacturing sector to achieve 99% diversion from landfills for the waste generated at the Nirlep factory. As a result, the company was able to recycle 247 tons of non-hazardous and hazardous waste. Around 50+ types of waste were identified and tracked in terms of their origin and disposal. It translated into a dramatic reduction of adverse environmental impacts, with the measures being implemented at all levels of organizations and vendor sites. Monetary benefits were realized by utilizing the waste for suitable commercial use. As customers across the globe appreciated their efforts, their brand equity increased severalfold. With Intertek Certification, many new business opportunities opened up for the company in multiple countries where environmental conservation is viewed as a non-negotiable criteria.

After the successful completion of the project, Anuj Poddar, executive director of Bajaj Electricals and Nirlep, was quoted as saying, *“Environment sustainability is a crucial aspect of any responsible corporate today. We are committed to reducing our carbon footprint and have integrated holistic waste management as a central part of our manufacturing process. Our aim is to create a safe and healthy workplace and institute a model that others in the sector can emulate to become environmentally conscious too. The ‘Zero Waste to Landfill’ certification by Intertek is definitely an encouraging milestone that has given us the impetus to amplify our efforts further”* [18,19].

4. Epilogue

Rameshwaram was promoted to lead the initiative in other divisions of the company. Overall, it was a win-win situation for Rameshwaram and his team as they continued to replicate the Nirlep model in other subsidiaries.

Author’s disclaimer note: The case has been developed by the author using secondary data available in the public domain (company website, annual reports, and media coverage along with key inputs from the company executives). The case has been written for the sole purpose of highlighting the company’s achievements in the area of supply chain sustainability and can be used for teaching purposes and demonstrating practical applications of the theoretical concepts.

Conflict of interest: The author declares no conflict of interest.

References

1. Wang Z, Sarkis J. Investigating the relationship of sustainable supply chain management with corporate financial performance. *International Journal of Productivity and Performance Management*. 2013, 62(8): 871-888. doi: 10.1108/ijppm-03-2013-0033
2. Giannakis M, Papadopoulos T. Supply chain sustainability: A risk management approach. *International Journal of Production Economics*. 2016, 171: 455-470. doi: 10.1016/j.ijpe.2015.06.032
3. Elkington J. The triple bottom line. *Environmental management: Readings and Cases*. 1997, 2: 49-66.
4. Miller K. The triple bottom line: What it is & why it's important. Available online: https://online.hbs.edu/blog/post/what-is-the-triple-bottom-line?c1=GAW_CM_NW&source=INTL_GEN_PMAX&cr2=content_-_international_-_gen_-_pmax&kw=general&cr5=&cr6=&cr7=c&utm_campaign=content_-_international_-_gen_-_pmax&utm_term=general&gad_source=1&gclid=CjwKCAiA_tuuBhAUEiwAvxkgTrTbcBFOeseFExVOr7BeAypFrvltTUaTRqvwphCUUB_aa64oDnlpDxoCdjoQAvD_BwE (accessed on 22 February 2024).
5. BAJAJ. 82nd annual report 2020-21. Available online: <https://www.bajajelectricals.com/media/7082/annual-report-bajaj-electricals-limited-2020-21.pdf> (accessed on 22 February 2024).
6. Zero Waste International Alliance. Available online: <https://zwia.org/> (accessed on 22 February 2024).
7. Seuring S, Müller M. From a literature review to a conceptual framework for sustainable supply chain management. *Journal of Cleaner Production*. 2008, 16(15): 1699-1710. doi: 10.1016/j.jclepro.2008.04.020
8. Carter CR, Liane Easton P. Sustainable supply chain management: evolution and future directions. *International Journal of Physical Distribution & Logistics Management*. 2011, 41(1): 46-62. doi: 10.1108/09600031111101420
9. Carter CR, Rogers DS. A framework of sustainable supply chain management: moving toward new theory. *International Journal of Physical Distribution & Logistics Management*. 2008, 38(5): 360-387. doi: 10.1108/09600030810882816
10. Geissdoerfer M, Savaget P, Bocken NMP, et al. The Circular Economy – A new sustainability paradigm? *Journal of Cleaner Production*. 2017, 143: 757-768. doi: 10.1016/j.jclepro.2016.12.048
11. Geng Y, Sarkis J, Bleischwitz R. How to globalize the circular economy. *Nature*. 2019, 565(7738): 153-155. doi: 10.1038/d41586-019-00017-z
12. Guide VDR, Harrison TP, Van Wassenhove LN. The Challenge of Closed-Loop Supply Chains. *Interfaces*. 2003, 33(6): 3-6. doi: 10.1287/inte.33.6.3.25182
13. Kumar NR, Kumar RS. Closed loop supply chain management and reverse logistics—A literature review. *International Journal of Engineering Research and Technology*. 2013, 6(4): 455-468.
14. Govindan K, Soleimani H, Kannan D. Reverse logistics and closed-loop supply chain: A comprehensive review to explore the future. *European Journal of Operational Research*. 2015, 240(3): 603-626. doi: 10.1016/j.ejor.2014.07.012
15. Krausz R, Hughey KF, Montgomery RL. Zero waste to landfill: An unacknowledged supermegaproject. *Lincoln Planning Review*. 2013, 5(1-2): 10-26.
16. Yang J. *From Zero Waste to Material Closed Loop*. Springer; 2022. doi: 10.1007/978-981-16-7683-3
17. Franco-García ML, Carpio-Aguilar JC, Bressers H. *Towards Zero Waste, Circular Economy Boost: Waste to Resources*. Springer International Publishing; 2019. pp. 1-8.
18. Indian Retailer Bureau. Bajaj electricals' nirlep appliances receives 'Zero Waste to Landfill' certification by Intertek. Available online: <https://www.indianretailer.com/news/bajaj-electricals-nirlep-appliances-receives-zero-waste-to-landfill-certification-by-intertek.n11438/> (accessed on 22 February 2024).
19. Tennews. Bajaj electricals subsidiary nirlep appliances receives 'Zero Waste to Landfill' certification for 99% waste diverted from landfills. Available online: <https://tennews.in/bajaj-electricals-subsidiary-nirlep-appliances-receives-zero-waste-to-landfill-certification-for-99-waste-diverted-from-landfills/> (accessed on 22 February 2024).

Appendix

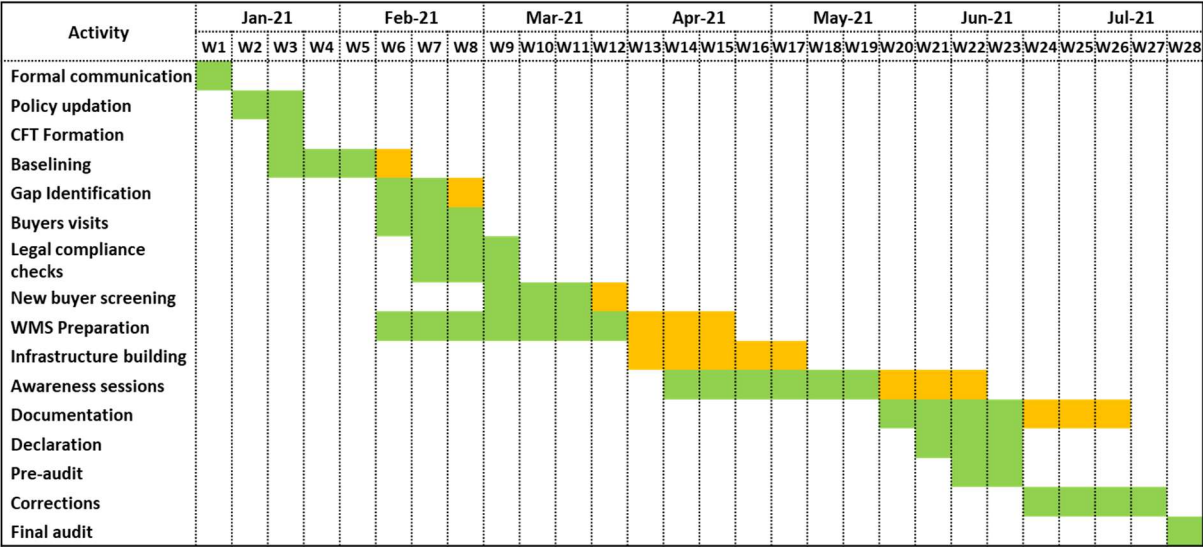


Figure A1. Project timeline.



Figure A2. Resources invested: Colour coded bins, waste segregator, storage shed and extensive staff training.

Review

Environmental finance under ESG: A literature review and synthesis

Chee Kong Yap^{1,*}, Chee Seng Leow², Aria Putra Ismail³¹ Department of Biology, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia² Humanology Sdn Bhd, 73-3 Amber Business Plaza, Jalan Jelawat 1, 56000 Kuala Lumpur, Malaysia³ Small Medium Enterprise Development Bank Malaysia Berhad, Menara SME Bank, Jalan Sultan Ismail, 50250 Kuala Lumpur, Malaysia* **Corresponding author:** Chee Kong Yap, yapchee@upm.edu.my**CITATION**

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Abstract: This paper aims to review the literature on ESG (environment, social, and governance) finance based on the Scopus database and synthesize the review. Three advantages of embracing ESG in corporate finance are identified based on the literature reviewed. First, this positively influences financial investment decisions; second, it can leverage advancements in technology and innovations; and third, it can create proactive risk management. Overall, it is still believed and conceptually accepted that integrating ESG criteria within the investment decision-making process brings a consolidated approach to the investment strategy, aligning social and environmental benefits with financial returns and driving positive performance and shareholder value in the long run.

Keywords: finance; ESG; environment; business

1. Introduction

Environment, social, and governance (ESG) factors have emerged as crucial considerations in the financial sector's decision-making process. Literature on 'ESG finance' can be widely found [1–53]. ESG encompasses many issues impacting companies' long-term sustainability and profitability [54]. Sustainability rating agencies provide comprehensive ESG ratings and evaluations that assist investors in assessing the ESG performance of companies [55]. By incorporating ESG scores and ratings into their analysis, investors can make more informed decisions and allocate capital to companies prioritising environmental responsibility, social impact, and strong corporate governance. ESG finance has become a significant megatrend, driving major changes in how businesses approach sustainability and long-term value creation. This trend has influenced the strategic decisions of top management and has brought forth a new paradigm in the allocation of capital investment [1–53].

Companies have accepted that ESG assessment plays a crucial role in reflecting their ESG performance accurately [1–10]. Investors increasingly incorporate ESG scores into their business analysis, using them as an evaluation tool to make more informed investment decisions. This shift has also prompted companies to implement ESG factors into their operational processes and investment strategies, recognizing them as key indicators of long-term success and shareholder value creation.

The expectation from investors and financial institutions on the “stakeholder values” of listed companies brings new challenges to both companies and financial markets [11–20]. The passive integration of ESG factors into the financial decision-making process has reshaped the landscape, leading to sustainability reports, ESG indices, and ratings provided by third-party authorities gaining prominence. The emergence of numerous sustainability rating agencies has further emphasized the

significance of ESG in the financial landscape, underscoring the growing acceptance of ESG assessment as a critical evaluation tool for investors and companies.

As companies strive to reflect their ESG performance accurately, investors are incorporating ESG scores into their business analysis to make more informed decisions [21–30]. In response, companies recognise the importance of integrating ESG factors into their operational processes and investment strategies, understanding their correlation with long-term success and shareholder value creation.

The objective of this study is to review the literature on ESG finance based on the Scopus database and synthesize the review.

2. Methodology

On 21 December 2023, using the keywords ‘ESG Finance’, 53 papers were reached using the Scopus database, which had high relevancy. Bibliometric analyses are an established method to evaluate research literature, particularly in scientific fields benefiting from computational data treatment and witnessing increased scholarly output [56]. VOSviewer is a software that generates a clear graphical representation of bibliometric maps, especially for extensive datasets [57]. To highlight the trends of studies conducted on the topic of ‘ESG Finance’ from 2015–2023 (on 53 papers from the Scopus database), we performed a bibliometric analysis using the VOSviewer software (VOS stands for visualization of similarities—see www.vosviewer.com).

Scopus comprises many significant research papers and offers integrated analysis tools for creating informative visual representations [58]. VOSviewer was employed to analyze each keyword, calculating links, total link strengths, and co-occurrences with other keywords.

3. Results and discussion

3.1. Increasing number of knowledge embracing ESG finance in the literature

The connections between finance and ESG have been found in the literature [1–53] since 2015 until recently (2023). All of the papers were published between 2020 and 2023, except one in 2015 [38].

Figure 1 gives a holistic overview of the past research based on keywords’ co-occurrences with ‘EGS Finance’. The analysis reveals a discernible prominence reflecting four principal domains of investigation, namely three significant clusters that can be identified based on visualization in **Figure 1** (top), such as a) sustainable development, b) sustainable finance, c) green finance, and d) green innovation. Many researchers [2019–2023] have recently focused on studies such as green innovation, commerce, ESG performance, energy use, financial systems and financial services, etc. (**Figure 1**; bottom). As an illustration, Zhang [22] examined the correlation between the advancement of green financing and the quality of enterprises’ ESG performance. This analysis used a dataset that included information from many firms from 2014 to 2020. They offered a prompt evaluation of the societal significance of

This literature hints that the ESG factor is becoming increasingly integrated into corporate strategies since it is recognized as a key indicator of a company's potential for generating shareholder value and long-term success. This shift has also led to the proliferation of sustainability reports and ESG indices and ratings provided by third-party authorities, which further emphasize the importance of ESG in the financial landscape. By incorporating ESG factors into financial decision-making, companies can effectively manage sustainability performance and meet the expectations of investors and stakeholders [54]. Moreover, the absence of standardized and mandatory micro-level ESG disclosure regulation in some markets, such as the Chinese bond market, presents challenges in accurately assessing ESG factors.

3.2. Advantages of embracing ESG

The advantages of embracing ESG have been indicated by many publications, highlighting the significant impact of ESG factors on investment risk and share value over time. As ESG considerations continue to gain prominence, they have become essential in assessing a company's long-term potential for sustainable value creation. Below are the three advantages of embracing ESG into corporate finance based on the literature reviewed [1–53].

3.2.1. Influence on financial investment decisions

Sustainable finance is generally understood as integrating ESG considerations into the investment process [44]. Investors across all asset classes increasingly integrate ESG criteria into their decision-making processes. This recognition of the influence of ESG factors on investment risk has led to a shift in mindset, where these considerations are considered crucial indicators of a company's long-term sustainability and financial performance. With a focus on environmental performance, social responsibility, and corporate governance, ESG factors have become key determinants for evaluating investment opportunities. Kim and Li [1] studied ESG and company financial performance. They examined how specific ESG categories, ESG strengths and weaknesses, and aggregate ESG factors affected business financial performance, including profitability and financial risk. They concluded that ESG aspects boost company profitability, especially for bigger enterprises. They also found that social factors affect credit ratings the most, whereas environmental scores negatively influence them. This research justifies ESG integration in investment management and portfolio creation to maximise value and minimise risk.

Bosone et al. [3] use a European company dataset to show that gender equality improves financial performance and sustainable investment. Archer [44] explained how the need to establish and quantify sustainability indicators reflects the market's rise as an ethical subject capable of making the most efficient ethical judgments. The implications for ethical intersubjectivity in sustainability are extensive.

In conclusion, this would drive sustainable investment strategies. The integration of ESG criteria within the investment decision-making process not only aligns social and environmental benefits with financial returns but also contributes to a consolidated approach to the investment strategy. By addressing environmental and social concerns, companies and investors can drive positive performance and shareholder value in the long run, leading to sustainability and long-term value creation.

3.2.2. Leveraging advancements in technology and innovations

Technological advancements and innovations transformed businesses and optimized numerous functional areas of financial services. Besides, green finance and fintech are also essential tools to achieve sustainable development agendas [5,7]. In the digital age, leveraging technology and data analytics can significantly enhance the assessment and monitoring of ESG factors. Advanced tools and platforms can provide real-time insights into ESG performance, allowing for more informed decision-making and proactive management of ESG-related risks and opportunities.

Wang et al. [33] used SynTao Green Finance's Chinese ESG ratings as a quasi-natural experiment to determine if ESG ratings affect corporate green innovation. They observed that ESG ratings improve green innovation quality and synergy. Thus, third-party ESG evaluations may boost corporate green innovation, helping enterprises reform and emerging markets strengthen ESG rating systems.

In a study of Chinese A-share listed enterprises from 2011 to 2020, Li and Pang [45] found that digital inclusive finance significantly improves corporate ESG performance. Still, corporate green technology innovation has a marginally increasing effect. Digitally inclusive finance may increase firms' green technology innovation, improving sustainability and ESG performance.

Ren et al. [46] examined how digital finance affects corporate ESG performance using 2011–2020 panel data from Chinese A-share listed enterprises. Three conclusions were drawn. They found that digital finance boosts corporate ESG performance, particularly environmental and social. Second, green innovation and external oversight showed that digital finance influences a company's ESG performance. Third, they found that digital finance affects enterprises with poor digitalization, profitability, regulated industries, and high carbon emissions.

Khalil et al. [5] examined innovation, green finance, financial technology, and ESG aspects in Gulf nations from 2000 to 2020 to estimate their impact on sustainable development. Policymakers and government organisations found their findings intriguing because they help strengthen governance evaluation systems and categorization criteria so nations may engage in sustainable development without obstacles.

3.2.3. Proactive risk management

By integrating ESG considerations into risk management frameworks, companies can proactively identify and mitigate ESG-related risks, safeguarding their long-term sustainability and resilience in the face of evolving market dynamics and stakeholder expectations. ESG risk is becoming increasingly important in ongoing environmental and social change conditions. This has specific implications for risk management in the public sector [25].

Zioło et al. [25] attempted to discover ESG elements affecting public finance using criteria in public decision-making and analyse links between public finance, ESG, risk, and efficiency. Public institutions' decision-making processes included ESG considerations, and risk, efficiency, and public finance system interdependencies were examined. Environmental issues have the greatest influence on public financial risk compared to social and governance issues. Carbon intensity emissions, which are connected to other environmental factors, are the most important. Their findings

should inform government environmental policy, particularly regarding greenhouse gas reduction and climate change.

Zeng et al. [2] measured the distance to default of Chinese online financing enterprises to determine their default risk. The ESG rating was included in their evaluation approach to consider default risk concerns. The regulator can use ESG to assess default risk to raise internet finance businesses' knowledge of the environment and sustainability's value to human societies. Morgan [17] argued that corporate ESG perspectives—managing risk and/or returning anticipated value—are insufficient to account for ESG finance trends. ESG derivatives are helping cybernetic finance turn climate uncertainty into price efficiency. Pisani and Russo [36] examined the returns, volatility, and contagion risk of a sample of sustainable investment funds during the COVID-19 financial crisis.

3.3. Some critics and arguments

While ESG has gained significant traction in the financial sector and is being adopted by many companies, there are dissenting views on its effectiveness as a tool for sustainable investment [59]. Some critics argue that focusing on ESG factors may lead to a narrow view of company performance and profitability. They point out that while environmental and social responsibility are important, they should not overshadow traditional financial metrics crucial for evaluating a company's success.

Additionally, there are concerns about the lack of standardized and mandatory ESG disclosure regulations in specific markets, which can lead to inconsistent and unreliable ESG data. Critics suggest that comparing ESG performance across companies and industries can be challenging without uniform reporting standards [60].

Furthermore, some argue that ESG ratings provided by third-party authorities may not always reflect a company's true sustainability efforts. There is a concern that companies could engage in "greenwashing," where they overstate their ESG initiatives to score favourably on ratings without making substantial changes to their actual practices [61].

Considering these opposing viewpoints and engaging in critical discourse about the role of ESG factors in the financial sector ensures that a balanced approach is maintained and the potential limitations are thoroughly understood. Still, it is undeniable that integrating ESG factors into financial decision-making processes has redefined how companies operate and has brought about substantial changes in the allocation of capital investment. The emergence of numerous sustainability rating agencies and the popularity of sustainability reports further emphasize the significance of ESG in the financial landscape [62].

As the importance of ESG continues to grow, companies and investors must navigate the challenges posed by the absence of standardized and mandatory micro-level ESG disclosure regulations. Finding and constructing multi-dimensional ESG factors can be a complex task, and there is a need for more comprehensive and consistent reporting standards to ensure the genuineness and comparability of ESG performance across companies and industries [63].

While dissenting views on the effectiveness of ESG as a tool for sustainable investment exist, it is imperative to acknowledge and address these concerns to

maintain a balanced approach [64]. This critical discourse will enable the financial sector to leverage the benefits of ESG while understanding and mitigating its potential limitations. ESG factors have become a significant consideration in environmental finance, with growing attention on their impact on company performance, industry trends, and sustainable investment strategies [65]. Investors increasingly integrate ESG criteria into their decision-making process across all asset classes, recognizing their influence on investment risk and share value over time. These factors, including environmental performance, social responsibility, and corporate governance, are crucial indicators of a company's long-term sustainability and financial performance. The growing focus on ESG factors has also incorporated these considerations into investment practices across all asset classes. Institutional investors see ESG factors as "extra-financial determinants" that hold increasing influence over the decision-making process. The impact of ESG factors on investment risk and share value over time has prompted a shift in mindset, where these considerations are viewed as essential in assessing a company's long-term potential for value creation.

The evolving focus on ESG factors has brought about significant changes in the financial sector, influencing how companies operate and allocate capital investment. This trend has also accentuated the importance of finding and constructing multi-dimensional ESG factors, overcoming the challenges posed by the absence of standardized and mandatory micro-level ESG disclosure regulation in specific markets. Efforts to address these challenges will ensure the genuineness and comparability of ESG performance across companies and industries [66].

Boiral et al. [19] investigated the value of ESG disclosure assurance in sustainable finance regulations and policies. Their study examined 188 comment letters from such players during public discussions on three new sustainable financing projects. They highlighted these players' complex and frequently critical views of external assurance's efficiency in combating greenwashing and their worries about its mandated character. These actors have raised concerns about the vagueness of verification practices, the lack of expertise in a new, specialized, and complex field, the costs of the assurance process, especially for small players, and the lack of control over ESG data reliability.

Sosa et al. [10] examined how Mexican oil prices affected two regimes. They suggested currency hedging in ESG investing. Originality comes from empirical methods and ESG index research in emerging markets. Limited information and ESG factor data are limitations. They found that tranquil and turbulent situations require distinct investing methods.

3.4. Research gaps

One key research gap in environmental finance under the ESG framework is the need for standardized and consistent measurement and reporting methodologies. By delving into these critical areas, the report will not only provide a comprehensive analysis of the existing gaps but will also offer actionable recommendations for advancing research and promoting the integration of ESG principles into environmental finance [67–75].

Another significant research gap in environmental finance under the ESG

framework is the need for more robust and comprehensive data sources. The availability and quality of data on environmental factors, such as carbon emissions, water usage, and waste management practices, vary widely across industries and regions. This hinders the ability of investors and financial institutions to assess and compare the environmental performance of different companies accurately. Additionally, research is needed to explore the long-term financial implications of climate change and other environmental risks [71–73].

3.5. Implications for future research, corporate strategy, and policymaking

ESG factors have implications for future research, corporate strategy, and policymaking.

For research, environmental finance is growing in interest and popularity, and ESG opens up new avenues for research. Researchers can explore the effectiveness of different strategies and approaches to environmental finance, such as green bonds or impact investing [74]. They can also investigate the relationship between ESG practices and financial performance and the long-term implications of environmental risks for businesses [75].

For corporate strategy, environmental finance and ESG considerations can significantly influence corporate strategy [76]. Companies now recognize the importance of integrating environmental and social considerations into business operations [75]. By incorporating ESG factors into their decision-making processes, companies can identify new opportunities for sustainable growth and mitigate potential risks [74].

Environmental finance and ESG considerations can inform policymaking at different levels. Policymakers can implement regulations and incentives to encourage companies to adopt ESG practices, leading to a more sustainable and resilient economy. They can also support the development of frameworks and standards for reporting and measuring ESG performance, promoting transparency and accountability in the corporate sector. Additionally, policymakers can collaborate with financial institutions to create financial instruments and investment opportunities that support environmental initiatives [76].

Overall, the implications of environmental finance and ESG for future research, corporate strategy, and policymaking are substantial. They highlight the need for further exploration and understanding of the effectiveness and impact of environmental finance strategies [74].

3.6. Biases and limitations in bibliometric analysis

Bibliometric analysis is a useful tool for evaluating research output and impact. However, it is important to acknowledge that there are potential biases in the selection of literature and limitations to consider when conducting bibliometric analysis. Some potential biases in the selection of literature for bibliometric analysis include language bias, publication bias, and accessibility bias [77].

Publication bias in bibliometric analysis refers to the tendency for studies with positive or significant results to be published. At the same time, those with negative

or non-significant findings are often left unpublished. This can lead to overestimating certain research outcomes and impact the validity of bibliometric analyses. Addressing publication bias requires careful consideration of strategies such as searching for unpublished literature, including grey literature, and incorporating methods to evaluate the impact of publication bias on the results [78,79].

Accessibility bias in bibliometric analysis arises from limitations in accessing certain types of literature, such as books, conference proceedings, and non-mainstream publications. Overcoming accessibility bias involves expanding search methods to include diverse literature sources, considering the inclusion of different publication types, and utilizing tools that facilitate comprehensive literature searches [80,81].

3.7. Practical applications for investors, companies, and policymakers

Implementing environmental finance under ESG has practical applications for investors, companies, and policymakers.

Environmental finance under ESG allows investors to align their investment strategies with sustainability goals. This can involve investing in companies that prioritize environmental conservation, promote social equity, and adhere to strong governance practices. Companies can benefit from environmental finance under ESG by integrating these principles into their business models. This can lead to improved financial performance, increased investor interest, and an enhanced reputation [76]. Additionally, policymakers can be crucial in encouraging companies to adopt ESG practices through regulation and incentives. By implementing and enforcing ESG regulations, policymakers can help create a level playing field and incentivize companies to adopt sustainable practices. Overall, the practical applications of environmental finance under ESG are wide-ranging.

4. Conclusion

In conclusion, the evolving focus on ESG factors has brought about significant changes in the financial sector, influencing how companies operate and allocate capital investment. This trend has also accentuated the importance of finding and constructing multi-dimensional ESG factors, overcoming the challenges posed by the absence of standardized and mandatory micro-level ESG disclosure regulation in specific markets. Efforts to address these challenges will ensure the genuineness and comparability of ESG performance across companies and industries.

On the plus side, embracing ESG factors in investment decisions is a critical step towards sustainable growth and value creation. The ongoing integration of ESG criteria will continue to shape the financial sector, influencing how companies operate, allocate capital investment, and ultimately contribute to long-term sustainable development. In summary, the evolving ESG landscape presents both opportunities and challenges for companies and investors. Embracing transparency, leveraging technology, fostering collaboration for standardization, promoting education and awareness, and integrating ESG into risk management are essential components of navigating this landscape and realizing the full potential of ESG for sustainable growth and value creation.

As the financial sector continues to navigate the complexities and potential limitations associated with integrating ESG factors, it becomes increasingly important to maintain a balanced approach. Critical discourse and a thorough understanding of dissenting viewpoints will enable companies and investors to leverage the benefits of ESG while addressing and mitigating its potential limitations. By acknowledging and addressing the concerns raised by critics, the financial sector can ensure that ESG factors are used effectively for sustainable investment, ultimately contributing to long-term value creation and sustainable growth. In essence, integrating ESG factors into investment decisions not only aligns social and environmental benefits with financial returns but also contributes to a consolidated approach to the investment strategy that drives positive performance and shareholder value in the long run.

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References

1. Kim S, Li Z (Frank). Understanding the Impact of ESG Practices in Corporate Finance. *Sustainability*. 2021, 13(7): 3746. doi: 10.3390/su13073746
2. Zeng L, Lau WY, Abdul Bahri EN. Can the modified ESG-KMV logit model explain the default risk of internet finance companies? *Frontiers in Environmental Science*. 2022, 10. doi: 10.3389/fenvs.2022.961239
3. Bosone C, Bogliardi SM, Giudici P. Are ESG Female? The Hidden Benefits of Female Presence on Sustainable Finance. *Review of Economic Analysis*. 2022, 14, 253-274.
4. Xue Q, Wang H, Bai C. Local green finance policies and corporate ESG performance. *International Review of Finance*. 2023, 23(4): 721-749. doi: 10.1111/irfi.12417
5. Khalil RG, Damrah S, Bajaher M, Shawtari FA. Unveiling the relationship of ESG, fintech, green finance, innovation and sustainability: case of Gulf countries. *Environmental Science and Pollution Research*. 2023, 30(54): 116299-116312. doi: 10.1007/s11356-023-30584-8
6. Thouvenot, Z. Sustainable Finance: The Hindered Potential of ESG Investing in Funding Climate Mitigation, Climate Adaptation and Resilience. In: *Climate Adaptation and Resilience: Challenges and Potential Solutions: Anticipatory Governance, Planning and Dialogue*. Peter Lang; 2022. pp. 297–318.
7. Bril H, Kell G, Rasche A. *Sustainability, Technology, and Finance*. Routledge; 2022. doi: 10.4324/9781003262039
8. Sun X, Zhou C, Gan Z. Green Finance Policy and ESG Performance: Evidence from Chinese Manufacturing Firms. *Sustainability*. 2023, 15(8): 6781. doi: 10.3390/su15086781
9. Gillan SL, Koch A, Starks LT. Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*. 2021, 66: 101889. doi: 10.1016/j.jcorpfin.2021.101889
10. Sosa M, Ortiz E, Cabello A. ESG Green Equity Finance Risk and Links in Mexico: Conditional Volatility and Markov Switching Vector Analyses. *Octubre - Diciembre 2022: Current Issues on Globalization and Sustainable Development*. 2022, 17(4): 1-21. doi: 10.21919/remef.v17i4.788
11. Branco MC. CSR research in corporate finance: a comment on Gillan et al., “firms and social responsibility: a review of ESG and CSR research in corporate finance.” *Sustainability Accounting, Management and Policy Journal*. 2023, 15(1): 85-95. doi: 10.1108/sampj-05-2023-0269
12. Ng AW. Emerging green finance hubs in Asia: Regulatory initiatives for ESG investing and green bond development by the Four Tigers. In: Nguyen DK (editor). *Handbook of Banking and Finance in Emerging Markets*. Edward Elgar Publishing; 2022. pp. 539-552. doi: 10.4337/9781800880900.00039
13. Rachev S (Zari), Lindquist WB. Editorial on the Volume “ESG Investing and ESG Finance.” *Journal of Risk and Financial Management*. 2023, 16(10): 422. doi: 10.3390/jrfm16100422
14. Daroshka V, Aleksandrov I, Fedorova M, et al. Agriculture and ESG transformation: Domestic and foreign experience of green agribusiness finance. In: Beskopylny A, Shamtsyan M, Artiukh V (editors). *XV International Scientific Conference “INTERAGROMASH 2022”*. Springer; 2023. pp. 2357–2368.

15. Makhkambaev AT, Karanina EV, Sinyavsky NG, Sotivaldiyeva DA. Development of Green Finance Based on ESG Tools of Investment Management in Russia and Central Asia. In: Popkova EG, Sergi BS (editors). *ESG Management of the Development of the Green Economy in Central Asia*. Springer; 2023. pp. 439-447. doi: 10.1007/978-3-031-46525-3_46
16. Karahan E. Regulatory Actions in Finance and How It Can Help Adopting ESG Criteria. In: Özkul F, Bayram S (editors). *Great Reset and The New Deal After Covid-19*. Peter Lang; 2022. pp. 123-148.
17. Morgan WR. Finance Must Be Defended: Cybernetics, Neoliberalism and Environmental, Social, and Governance (ESG). *Sustainability*. 2023, 15(4): 3707. doi: 10.3390/su15043707
18. Blaschke, T. Taxonomy Regulation, Sustainable Finance, ESG Data and Geoinformatics. *gis. Business*, 2022, 45–46.
19. Boiral O, Brotherton MC, Talbot D. What you see is what you get? Building confidence in ESG disclosures for sustainable finance through external assurance. *Business Ethics, the Environment & Responsibility*. 2023. doi: 10.1111/beer.12630
20. Poyser A, Daugaard D. Indigenous sustainable finance as a research field: A systematic literature review on indigenising ESG, sustainability and indigenous community practices. *Accounting & Finance*. 2023, 63(1): 47-76. doi: 10.1111/acfi.13062
21. Application of an Environmental, Social and Governance (ESG) Course to Enhance the Knowledge of Sustainable Finance of International Chinese College Students in Thailand. *Journal of Higher Education Theory and Practice*. 2022, 22(11). doi: 10.33423/jhetp.v22i11.5411
22. Zhang D. Does green finance really inhibit extreme hypocritical ESG risk? A greenwashing perspective exploration. *Energy Economics*. 2023, 121: 106688. doi: 10.1016/j.eneco.2023.106688
23. Chang X, Fu K, Jin Y, Liem PF. Sustainable Finance: ESG/CSR, Firm Value, and Investment Returns*. *Asia-Pacific Journal of Financial Studies*. 2022, 51(3): 325-371. doi: 10.1111/ajfs.12379
24. Egorova D. ESG-finance principles as the key drivers of Russian regions' investment potential. *E3S Web of Conferences*. 2020, 208: 01013. doi: 10.1051/e3sconf/202020801013
25. Ziolo M, Filipiak BZ, Bąk I, Cheba K. How Do Environmental, Social, and Governance (ESG) Factors Impact on Public Finance Performance? Risk, Efficiency, and Public Financial System Perspectives. In: Bem A, Daszynska-Zygadlo K, Hajdíkóvá T, et al. (editors). *Sustainable Finance in the Green Economy: The 3rd Finance and Sustainability Conference, Wrocław 2019*. Springer; 2022. pp. 261-275.
26. Pasch S, Ehnes D. NLP for Responsible Finance: Fine-Tuning Transformer-Based Models for ESG. In: *Proceedings of the 2022 IEEE International Conference on Big Data (IEEE BigData 2022)*; 17-20 December; Osaka, Japan. doi: 10.1109/bigdata55660.2022.10020755
27. Morphet A, Lau J, Gabig N, et al. Incorporating ESG in Structured Finance. *The Journal of Structured Finance*. 2023, 29(1): 65-76. doi: 10.3905/jsf.2023.1.154
28. Zeidan R. Why don't asset managers accelerate ESG investing? A sentiment analysis based on 13,000 messages from finance professionals. *Business Strategy and the Environment*. 2022, 31(7): 3028-3039. doi: 10.1002/bse.3062
29. Starks LT. Presidential Address: Sustainable Finance and ESG Issues—Value versus Values. *The Journal of Finance*. 2023, 78(4): 1837-1872. doi: 10.1111/jofi.13255
30. Usul N, Yilmaz IS. Corporate Sustainability: The Use of ESG Scores in Finance Research. In: *Corporate Sustainability as a Tool for Improving Economic, Social, and Environmental Performance*. IGI Global; 2023. doi: 10.4018/978-1-6684-7422-8.ch001
31. Daroshka V, Aleksandrov I, Trushkin V, et al. Climate bonds and their role in the development of ESG-finance banking practice: Global and Russian experiences. *E3S Web of Conferences*. 2023, 431: 07021. doi: 10.1051/e3sconf/202343107021
32. Paltrinieri A, Dreassi A, Migliavacca M, Piserà S. Islamic finance development and banking ESG scores: Evidence from a cross-country analysis. *Research in International Business and Finance*. 2020, 51: 101100. doi: 10.1016/j.ribaf.2019.101100
33. Wang J, Ma M, Dong T, Zhang Z. Do ESG ratings promote corporate green innovation? A quasi-natural experiment based on SynTao Green Finance's ESG ratings. *International Review of Financial Analysis*. 2023, 87: 102623. doi: 10.1016/j.irfa.2023.102623
34. Kazachenok OP, Stankevich GV, Chubaeva NN, Tyurina YG. Economic and legal approaches to the humanization of FinTech in the economy of artificial intelligence through the integration of blockchain into ESG Finance. *Humanities and Social Sciences Communications*. 2023, 10(1). doi: 10.1057/s41599-023-01652-8
35. Chang K, Cheng X, Wang Y, et al. The impacts of ESG performance and digital finance on corporate financing efficiency in China. *Applied Economics Letters*. 2021, 30(4): 516-523. doi: 10.1080/13504851.2021.1996527

36. Pisani F, Russo G. Sustainable Finance and COVID-19: The Reaction of ESG Funds to the 2020 Crisis. *Sustainability*. 2021, 13(23): 13253. doi: 10.3390/su132313253
37. Mahomed AMZ, Mohamad S. Sustainable Finance and a Shari' Analysis of Environmental, Social and Governance (ESG) Criteria. In: Hassan MK, Saraç M, Khan A (editors). *Islamic Finance and Sustainable Development: A Sustainable Economic Framework for Muslim and Non-Muslim Countries*. Palgrave Macmillan; 2021. pp. 193-217. doi: 10.1007/978-3-030-76016-8_9
38. Sairally BS. Integrating Environmental, Social and Governance (ESG) Factors in Islamic Finance: Towards the Realisation of Maqāṣid al-Sharī'ah. *ISRA International Journal of Islamic Finance*. 2015, 7: 145-154.
39. Zhang D. Can digital finance empowerment reduce extreme ESG hypocrisy resistance to improve green innovation? *Energy Economics*. 2023, 125: 106756. doi: 10.1016/j.eneco.2023.106756
40. Mo Y, Che Y, Ning W. Digital Finance Promotes Corporate ESG Performance: Evidence from China. *Sustainability*. 2023, 15(14): 11323. doi: 10.3390/su151411323
41. Weston P, Nnadi M. Evaluation of strategic and financial variables of corporate sustainability and ESG policies on corporate finance performance. *Journal of Sustainable Finance & Investment*. 2021, 13(2): 1058-1074. doi: 10.1080/20430795.2021.1883984
42. Park YS, Lee HS. The Roles of Finance in ESG Management. *Asia-Pacific Journal of Financial Studies*. 2023, 52(3): 354-373. doi: 10.1111/ajfs.12436
43. Mu W, Liu K, Tao Y, Ye Y. Digital finance and corporate ESG. *Finance Research Letters*. 2023, 51: 103426. doi: 10.1016/j.frl.2022.103426
44. Archer M. The ethics of ESG. *Focaal*. 2022, 2022(93): 18-31. doi: 10.3167/fcl.2022.930102
45. Li W, Pang W. The impact of digital inclusive finance on corporate ESG performance: based on the perspective of corporate green technology innovation. *Environmental Science and Pollution Research*. 2023, 30(24): 65314-65327. doi: 10.1007/s11356-023-27057-3
46. Ren X, Zeng G, Zhao Y. Digital finance and corporate ESG performance: Empirical evidence from listed companies in China. *Pacific-Basin Finance Journal*. 2023, 79: 102019. doi: 10.1016/j.pacfin.2023.102019
47. Jiang W, Dong L, Chen Y. Time-frequency connectedness among traditional/new energy, green finance, and ESG in pre- and post-Russia-Ukraine war periods. *Resources Policy*. 2023, 83: 103618. doi: 10.1016/j.resourpol.2023.103618
48. Xue L, Dong J, Zha Y. How does digital finance affect firm environmental, social and governance (ESG) performance?—Evidence from Chinese listed firms. *Heliyon*. 2023, 9(10): e20800. doi: 10.1016/j.heliyon.2023.e20800
49. Ning Y, Zhang Y. Does Digital Finance Improve Corporate ESG Performance? An Intermediary Role Based on Financing Constraints. *Sustainability*. 2023, 15(13): 10685. doi: 10.3390/su151310685
50. Bertelli, F. ESG risks in banking and finance. *Actual. Juridica Iberoam*. 2023, 1680-1707.
51. Harengel, J. Three Letters in Order to Operate More Sustainably: ESG - Why Every Company Can Benefit from ESG-Linked Finance. *Stahl Eisen* 2022, 142, 30-32.
52. Gözlügöl AA. The clash of 'E' and 'S' of ESG: just transition on the path to net zero and the implications for sustainable corporate governance and finance. *The Journal of World Energy Law & Business*. 2022, 15(1): 1-21. doi: 10.1093/jwelb/jwab039
53. Causevic A, Beslik S, Causevic S. *Quo vadis* sustainable finance: Why defensive weapons should never be classified as an ESG investment. *Journal of Sustainable Finance & Investment*. 2022, 1-9. doi: 10.1080/20430795.2022.2135965
54. Chen CD, Su CH (Joan), Chen MH. Understanding how ESG-focused airlines reduce the impact of the COVID-19 pandemic on stock returns. *Journal of Air Transport Management*. 2022, 102: 102229. doi: 10.1016/j.jairtraman.2022.102229
55. Zheng J, Khurram MU, Chen L. Can Green Innovation Affect ESG Ratings and Financial Performance? Evidence from Chinese GEM Listed Companies. *Sustainability*. 2022, 14(14): 8677. doi: 10.3390/su14148677
56. Ellegaard O, Wallin JA. The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*. 2015, 105(3): 1809-1831. doi: 10.1007/s11192-015-1645-z
57. van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*. 2009, 84(2): 523-538. doi: 10.1007/s11192-009-0146-3
58. Guz AN, Rushchitsky JJ. Scopus: A system for the evaluation of scientific journals. *International Applied Mechanics*. 2009, 45(4): 351-362. doi: 10.1007/s10778-009-0189-4

59. Glazerman G, Cohen J. “Non-Financial” Is a Misnomer, but Doesn’t Have to Be a Missed Opportunity. *Journal of Applied Corporate Finance*. 2020, 32(2): 108-116. doi: 10.1111/jacf.12410
60. Kotsantonis S, Pinney C, Serafeim G. ESG Integration in Investment Management: Myths and Realities. *Journal of Applied Corporate Finance*. 2016, 28(2): 10-16. doi: 10.1111/jacf.12169
61. Lydenberg S. Integrating Systemic Risk into Modern Portfolio Theory and Practice. *Journal of Applied Corporate Finance*. 2016, 28(2): 56-61. doi: 10.1111/jacf.12175
62. Schramade W. Bridging Sustainability and Finance: The Value Driver Adjustment Approach. *Journal of Applied Corporate Finance*. 2016, 28(2): 17-28. doi: 10.1111/jacf.12170
63. Verheyden T, Eccles RG, Feiner A. ESG for All? The Impact of ESG Screening on Return, Risk, and Diversification. *Journal of Applied Corporate Finance*. 2016, 28(2): 47-55. doi: 10.1111/jacf.12174
64. Raman N, Bang G, Nourbakhsh A. Mapping ESG Trends by Distant Supervision of Neural Language Models. *Machine Learning and Knowledge Extraction*. 2020, 2(4): 453-468. doi: 10.3390/make2040025
65. Salampasis, D. Leveraging robo-advisors to fill the gap within the SRI marketplace. Available online: https://scite.ai/reports/10.24840/2183-0606_005.003_0002 (accessed on 5 January 2024).
66. Höck A, Klein C, Landau A, et al. The effect of environmental sustainability on credit risk. *Journal of Asset Management*. 2020, 21(2): 85-93. doi: 10.1057/s41260-020-00155-4
67. Liang H, Renneboog L. Corporate Social Responsibility and Sustainable Finance: A Review of the Literature. *SSRN Electronic Journal*. 2020. doi: 10.2139/ssrn.3698631
68. Qi Y, Li X. On Imposing ESG Constraints of Portfolio Selection for Sustainable Investment and Comparing the Efficient Frontiers in the Weight Space. *SAGE Open*. 2020, 10(4): 215824402097507. doi: 10.1177/2158244020975070
69. Gillan SL, Koch A, Starks LT. Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*. 2021, 66: 101889. doi: 10.1016/j.jcorpfin.2021.101889
70. Repetto R. Protecting investors and the environment through financial disclosure. *Utilities Policy*. 2005, 13(1): 51-68. doi: 10.1016/j.jup.2004.07.001
71. Atz U, Van Holt T, Liu Z. Do corporate sustainability and sustainable finance generate better financial performance? Available online: <https://clsbluesky.law.columbia.edu/2020/12/15/do-corporate-sustainability-and-sustainable-finance-generate-better-financial-performance/> (accessed on 5 January 2024).
72. Kumar S, Sharma D, Rao S, et al. Correction to: Past, present, and future of sustainable finance: insights from big data analytics through machine learning of scholarly research. *Annals of Operations Research*. 2022. doi: 10.1007/s10479-022-04535-4
73. Atz U, Van Holt T, Liu ZZ, Bruno CC. Does sustainability generate better financial performance? review, meta-analysis, and propositions. *Journal of Sustainable Finance & Investment*. 2022, 13(1): 802-825. doi: 10.1080/20430795.2022.2106934
74. Gillan SL, Koch A, Starks LT. Firms and social responsibility: A review of ESG and CSR research in corporate finance. *Journal of Corporate Finance*. 2021, 66: 101889. doi: 10.1016/j.jcorpfin.2021.101889
75. Kulal A, Abhishek N, Dinesh S, Divyashree MS. Impact of Environmental, Social, and Governance (ESG) Factors on Stock Prices and Investment Performance. *Macro Management & Public Policies*. 2023, 5(2): 14-26. doi: 10.30564/mmpp.v5i2.5659
76. Donthu N, Kumar S, Mukherjee D, et al. How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*. 2021, 133: 285-296. doi: 10.1016/j.jbusres.2021.04.070
77. Sibbald SL, MacGregor JCD, Surmacz M, Wathen CN. Into the gray: A modified approach to citation analysis to better understand research impact. *Journal of the Medical Library Association: JMLA*. 2015, 103(1): 49-54. doi: 10.3163/1536-5050.103.1.010
78. Rousseau S, Rousseau R. Bibliometric techniques and their use in business and economics research. *Journal of Economic Surveys*. 2021, 35(5): 1428-1451. doi: 10.1111/joes.12415
79. Agarwal A, Durairajanayagam D, Tatagari S, et al. Bibliometrics: tracking research impact by selecting the appropriate metrics. *Asian Journal of Andrology*. 2016, 18(2): 296. doi: 10.4103/1008-682x.171582
80. Belter CW. Bibliometric indicators: opportunities and limits. *Journal of the Medical Library Association: JMLA*. 2015, 103(4): 219-221. doi: 10.3163/1536-5050.103.4.014
81. Davis T, Lescott B. ESG as a Value-Creation Tool for Active Investors: A Profile of Inherent Group. *Journal of Applied Corporate Finance*. 2019, 31(2): 42-49. doi: 10.1111/jacf.12345

Review

A review of the active industrial area at Pasir Gudang area, Johore: Some notes and knowledge gaps

Chee Kong Yap^{1,*}, Nur Faradilla Mohd Sabri¹, Krishnan Kumar², Mohamad Saupi Ismail³, Rosimah Nulit¹, Hideo Okamura⁴, Yoshifumi Horie⁴, Meng Chuan Ong^{5,6}, Ahmad Dwi Setyawan^{7,8}, Chee Wah Yap⁹, Hishamudin Omar¹, Kennedy Aaron Aguol¹⁰, Wan Hee Cheng², Chee Seng Leow¹¹

¹ Department of Biology, Faculty of Science, Universiti Putra Malaysia, UPM Serdang, Serdang 43400, Malaysia

² Faculty of Health and Life Sciences, INTI International University, Persiaran Perdana BBN, Nilai 71800, Malaysia

³ Fisheries Research Institute, Batu Maung, Pulau Pinang 11960, Malaysia

⁴ Graduate School of Maritime Sciences, Faculty of Maritime Sciences, Kobe University, Kobe 658-0022, Japan

⁵ Faculty of Science and Marine Environment, Universiti Malaysia Terengganu, Kuala Nerus 21030, Malaysia

⁶ Ocean Pollution and Ecotoxicology (OPEC) Research Group, Universiti Malaysia Terengganu, Kuala Nerus 21030, Malaysia

⁷ Department of Environmental Science, Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret, Kota Surakarta 57126, Indonesia

⁸ Biodiversity Research Group, Universitas Sebelas Maret, Kota Surakarta 57126, Indonesia

⁹ MES SOLUTIONS, 22C-1, Jalan BK 5A/2A, Bandar Kinrara, Puchong 47100, Malaysia

¹⁰ Centre for Promotion of Knowledge and Language Learning (CPKLL), Universiti Malaysia Sabah, Kota Kinabalu 88400, Malaysia

¹¹ Humanology Sdn Bhd, 73-3 Amber Business Plaza, Jalan Jelawat 1, Kuala Lumpur 56000, Malaysia

* **Corresponding author:** Chee Kong Yap, yapchee@upm.edu.my

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Abstract: This study aimed to examine the literature on Pasir Gudang, analyse the gathered material, and identify areas lacking knowledge. The literature research reveals that the published studies may be classified into hydrological, monitoring and forecasting, social, economic, and environmental issues. Nevertheless, the subjects of conservation, preservation, pollution recovery, and bioremediation, particularly environmental, social, and governance (ESG) concerns, have been of recent interest. Thus, these information gaps are strongly advised to be addressed in future research in and around the busy Pasir Gudang industrial sector.

Keywords: industrial area; Pasir Gudang; Johore

1. Introduction

The literature contains investigations conducted in Pasir Gudang [1–28]. The pollution in Pasir Gudang, mostly resulting from urbanisation, industrialization, and agricultural activities, has a substantial influence on the environment. The pollution has a dual impact, both on the water quality of the Kim Kim River and on the air pollution levels in the vicinity [29]. Water pollution in Pasir Gudang has had a significant surge and variety due to the rapid growth of its industry-driven economy [10]. Pasir Gudang is a crucial location for scientific research because of its extensive industrial operations and the considerable environmental consequences it generates [30,31]. The fast expansion, industry, and urbanisation of Pasir Gudang have led to significant worries over rainfall and pollution in the area [4]. Furthermore, the occurrence of illicit hazardous garbage in 2019 emphasised the susceptibility of Pasir Gudang to environmental contamination [4]. This can be supported by the recent observational research conducted in the Pasir Gudang area, namely in Sungai Kim Kim, Kg. Pasir Puteh, Kg. Kuala Masai, and Kg. Teluk Jawa, between the dates of 26th October and 26th November 2022 (**Figure 1**).

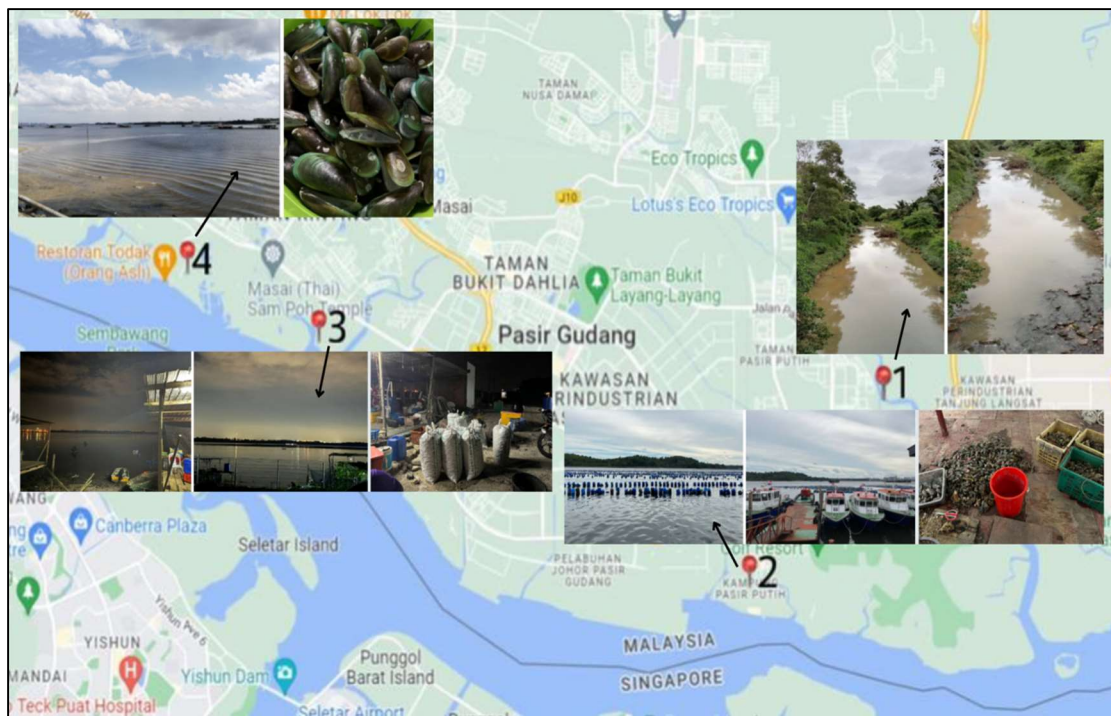


Figure 1. Observational activities around Pasir Gudang area at (1) Sungai Kim Kim, (2) Kg. Pasir Puteh, (3) Kg. Kuala Masai, and (4) Kg. Teluk Jawa from Google Maps (Accessed from 26th October 2022–26th November 2022).

The objective of this study was to review the publications on Pasir Gudang and to discuss the reviewed information, and to understand the knowledge gaps.

2. Methodology

Information relating to daily data on rainfall and water level was collected through reports from the official website of the Public Infobanjir (<https://publicinfobanjir.water.gov.my/?lang=en>; assessed between 21st October 2022 to 9th November 2022). For water quality data collection, the observation method captured situations in Sungai Kim Kim, Kg. Pasir Puteh, Kg. Kuala Masai, and Kg. Teluk Jawa. Model iPhone 13 was used throughout the observation process. In addition, local and international research was also represented. The terms “Sungai Kim Kim,” “Kg. Pasir Puteh,” “Kg. Kuala Masai,” and “Kg. Teluk Jawa,” “flood,” “rainfall,” and “water level” were used as keywords.

On 18 December 2023, 36 papers were reached using the Scopus database using the keywords ‘Pasir Gudang’. After checking the relevancy of the papers, only 28 papers were retained. Bibliometric analyses are an established method to evaluate research literature, particularly in scientific fields benefiting from computational data treatment and witnessing increased scholarly output [32]. VOSviewer is a software that generates a clear graphical representation of bibliometric maps, especially for extensive datasets [33]. To highlight the trends of studies conducted on the topic of ‘Pasir Gudang’, from 1983–2023 (on 29 papers from the Scopus database; **Table 1**), we performed a bibliometric analysis using the VOSviewer software (VOS stands for visualization of similarities—see www.vosviewer.com).

Table 1. Studies conducted on the topic of ‘Pasir Gudang’, from 1983–2023 based on the Scopus database.

No.	Authors	Title	Year	Source title	Volume	Issue
1	Lee JH et al. [1]	Water Distribution System Modelling in Pasir Gudang, Johor with EPANET	2023	Lecture Notes in Civil Engineering	293	-
2	Syed Mahdzar SS [2]	Streets for people: Sustaining accessible and sociable streets in Pasir Gudang City Centre	2013	2013 International Space Syntax Symposium	-	-
3	Sahrani FK et al. [3]	Isolation and identification of marine sulphate-reducing bacteria, <i>Desulfovibrio</i> sp. and <i>Citrobacter freundii</i> from Pasir Gudang, Malaysia	2008	Sains Malaysiana	37	4
4	Ibrahim MF et al. [4]	The impacts of illegal toxic waste dumping on children’s health: A review and case study from Pasir Gudang, Malaysia	2021	International Journal of Environmental Research and Public Health	18	5
5	Ismail SNS et al. [5]	A case study of Pasir Gudang chemical toxic pollution: A review on health symptoms, psychological manifestation and biomarker assessment	2020	Malaysian Journal of Medicine and Health Sciences	16	-
6	Abdul Majid Z and Zain RB [6]	The dental health of factory workers in Pasir Gudang, Johor (Malaysia).	1988	Dental journal of Malaysia	10	1
7	Ahmad NA et al. [7]	A Community-Based Emergency Response Management in Pasir Gudang, Johor: Theoretical Framework	2020	IOP Conference Series: Materials Science and Engineering	808	1
8	Tajik E et al. [8]	Unhealthy diet practice and symptoms of stress and depression among adolescents in Pasir Gudang, Malaysia	2016	Obesity Research and Clinical Practice	10	2
9	Teh BT et al. [9]	Determinant factors of industrial symbiosis: Greening Pasir Gudang industrial park	2014	IOP Conference Series: Earth and Environmental Science	18	1
10	Desa MS M et al. [10]	Water Quality Assessment and Characterization of Rivers in Pasir Gudang, Johor via Multivariate Statistical Techniques	2023	Pertanika Journal of Science and Technology	31	1
11	Zulkifli SN et al. [11]	Analysis of bacterial contaminant in Pasir Gudang, Johor tap water supply–Varies pH value observation	2018	International Journal of Engineering, Transactions B: Applications	31	8
12	Mahat NA et al. [12]	Toxic metals in <i>Perna viridis</i> mussel and surface seawater in Pasir Gudang coastal area, Malaysia, and its health implications	2018	Environmental Science and Pollution Research	25	30
13	Rahman NH A et al. [13]	Univariate and multivariate short-term solar power forecasting of 25MWac Pasir Gudang utility-scale photovoltaic system using LSTM approach	2023	Energy Reports	9	-
14	Mohamad Nor Zaki NK and Ahmad Bari NA [14]	A Study on the indoor air quality (IAQ) at primary school in Industrial Area: A case study to Sekolah Kebangsaan Pasir Gudang 3(SKPG3)	2022	IOP Conference Series: Earth and Environmental Science	1067	1
15	Eric J [15]	Paka and Pasir Gudang: fast track combined cycles for Malaysian IPP	1996	Turbomachinery International	37	2
16	Misnan MF et al. [16]	Smart Sustainable Water Monitoring System via Internet of Things (IoT) for Water Retention Pond UiTM Cawangan Johor, Kampus Pasir Gudang	2022	International Journal of Sustainable Construction Engineering and Technology	13	-
17	Ahmad NA et al. [17]	Appropriate Community-Based Emergency Response Elements for Toxic Gas Release in Pasir Gudang, Johor	2022	Lecture Notes in Civil Engineering	214	-

Table 1. (Continued).

No.	Authors	Title	Year	Source title	Volume	Issue
18	Zakari MD et al. [18]	Mapping and detection of hotspot sources from industrial area heat (IAH) using aerial and satellite-based TIR data in Pasir Gudang	2023	International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences - ISPRS Archives	48	-
19	Zulkifli NM et al. [19]	Performance of Several Statistical Methods in Forecasting Particulate Matter Concentrations in Pasir Gudang, Johor	2022	Studies in Systems, Decision and Control	444	-
20	Wan Ibrahim WY et al. [20]	Green space audits on its accessibility in Pasir Gudang	2013	Planning Malaysia	11	-
21	Latiff LA et al. [21]	Psychosocial problem and its associated factors among adolescents in the secondary schools in Pasir Gudang, Johor	2017	Malaysian Journal of Medicine and Health Sciences	13	1
22	Abas A and Din L [22]	Heavy Metal Concentration Assessment Using Transplanted Lichen Usnea Misaminensis at Pasir Gudang, Johor	2020	IOP Conference Series: Earth and Environmental Science	549	1
23	Ghafar AA et al. [23]	Comparison of leaf area index from four plant species on vertical greenery system in Pasir Gudang, Malaysia	2020	Pertanika Journal of Science and Technology	28	2
24	Thakar VS et al. [24]	Mathematical modelling of hydrothermal recirculation for Pasir Gudang Power Station, Malaysia	1983	Conference on Waste Heat Management and utilization. Miami Beach; USA, University of Miami; DA. 1981; PP. IV.A.51-IV.A.53		-
25	Siddique Md NI et al. [25]	Kinetic Modeling of Peroxydisulfate Pre-Treatment of Algae Slurry (Pasir Gudang, Malaysia) for Increasing Methane Generation from Anaerobic Digestion: Fertilizer Recovery	2022	Asian Journal of Chemistry	34	-
26	Yahya NYB et al. [26]	Preparedness towards Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) threats among healthcare personnel in Pasir Gudang, Johor, Malaysia	2022	International Journal of Disaster Risk Reduction	82	-
27	Mohammad Z et al. [27]	Fundamental Study of Energy Control System Lockout and Tagout (LOTO) Implementation in Manufacturing Industry at Pasir Gudang, Johor	2019	Test Engineering and Management	81	-
28	Sabeen AH et al. [28]	Minimizing the cost of municipal solid waste management in Pasir Gudang Johor Malaysia	2016	Journal of Materials and Environmental Science	7	5
27	Abdullah et al. [29]	Incidents of Poisonous Gas Spreading in Pasir Gudang, Johor, Malaysia: Responsibilities, Roles and Social Impacts on Communities	2023	Resmilitaris	13	1

Scopus comprises many significant research papers and offers integrated analysis tools for creating informative visual representations [34]. VOSviewer was employed to analyze each keyword, calculating links, total link strengths, and co-occurrences with other keywords.

3. Results

From all the literature reviews [1–28], they covered the significant themes of hydrology [1,24], monitoring and forecasting [14,16,18,19], environment [4,5,10–

12,20–23,27], social [2,6–8,17,26], and economy [9,28]. The following discussion will be based on the above significant themes.

4. Discussion

4.1. Hydrological aspect

Lee et al. [1] presented a water supply distribution system for the Pasir Gudang area in Johor by using EPANET software. The water distribution network that is modelled with EPANET consists of 26 water tanks, 38 junctions, 65 pipes, and one water treatment plant. The total amount of Epanet computed water demand is 215,160 million litres per day, which is higher than the required water demand of 206,070 million litres per day. Therefore, there is no shortage of water to affect the Pasir Gudang area, according to their study.

Rainfall data is an essential component for mathematical models dealing with extreme hydrological events, including droughts and floods, and for the evaluation of surface and groundwater resources and their quality [35,36]. **Figure 2** shows rainfall variation in different sites.

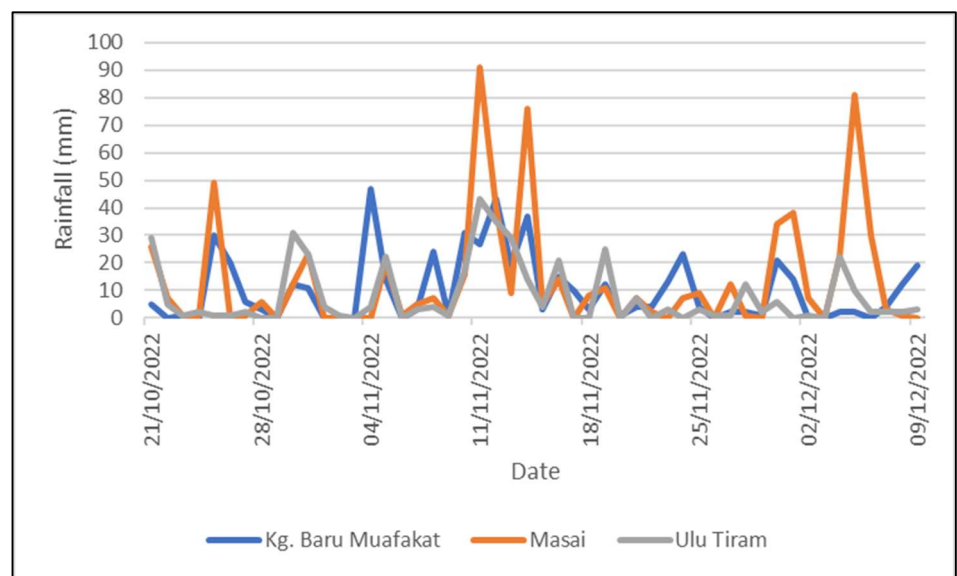


Figure 2. Rainfall variation from 21st October 2022 to 9th November 2022. Data cited from InfoBanjir (<https://publicinfobanjir.water.gov.my/?lang=en>; Accessed from 21st October 2022–9th November 2022).

From a social perspective, rainfall data helps humans decide how much water is needed for plants between rainfalls and know the best times for planting. Next, help identify weather patterns for the plan of outdoor activities. This can also help humans understand climate change and its effects on our environment. **Figures 3** and **4** show that the water level data is not significant for the sites. However, there could be an association between rainfall and water level data, namely that the water level increased along with an increase in rainfall data. More future studies are needed to understand groundwater flow systems, contributing to the preservation of river flow continuity.

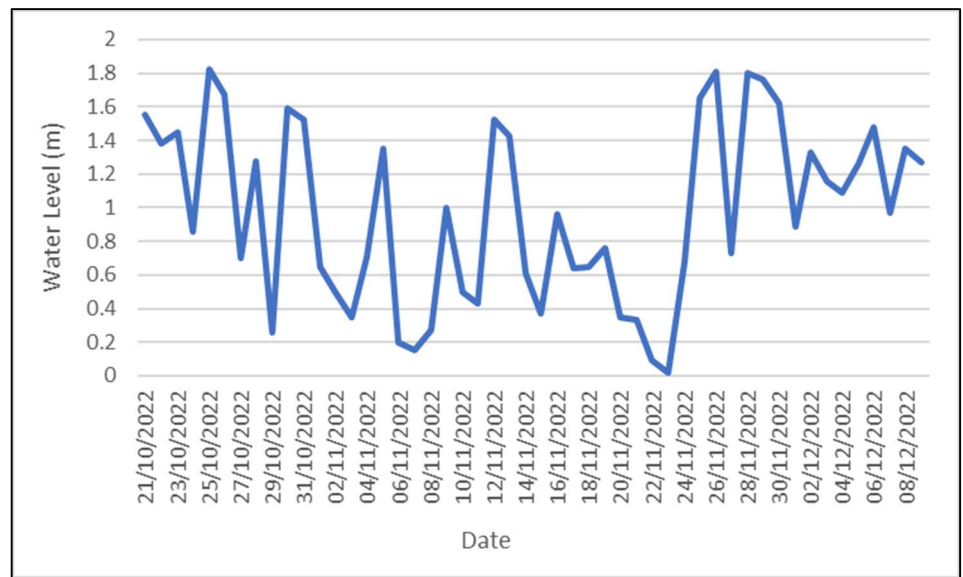


Figure 3. Water level variation in Sg. Tebrau, Kg. Sri Pandan from 21st October 2022 to 9th November 2022. Data cited from InfoBanjir (Accessed from 21st October 2022–9th November 2022).

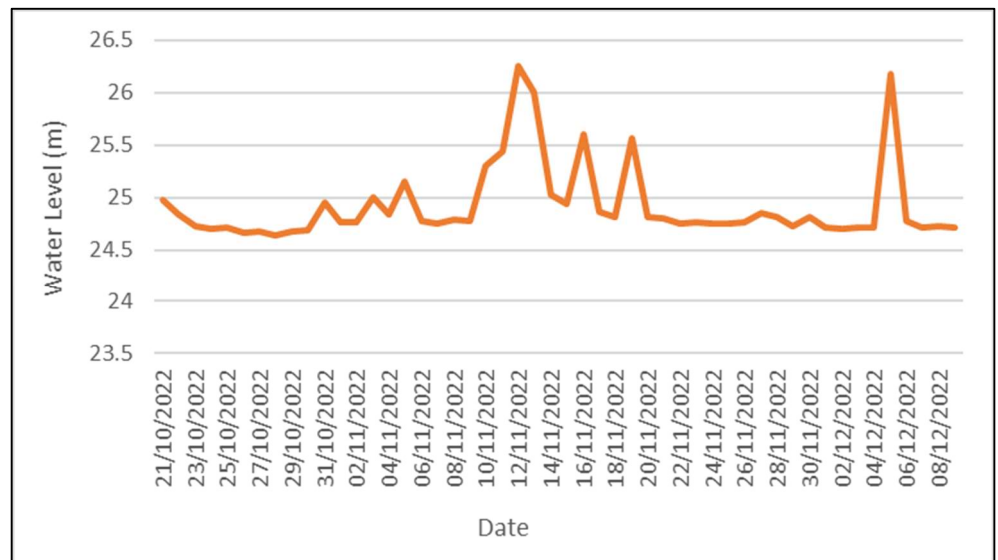


Figure 4. Water level variation in Sg. Tiram, Ulu Tiram from 21st October 2022 to 9th November 2022. Data cited from InfoBanjir (Accessed from 21st October 2022–9th November 2022).

4.2. Monitoring and forecasting

Previous studies have demonstrated that classrooms can contain significant quantities of air pollutants that may harm children's health and academic performance [14]. In Pasir Gudang, Johor Bahru's industrial district, Zaki and Bari [14] assessed a school's indoor air quality (IAQ). Formaldehyde (HCHO), TVOC, and PM were measured in the classroom. The classroom's physical characteristics were good, but the relative humidity was too high. On chemical contaminants, the classroom PM, HCHO, and TVOC concentrations are still within acceptable limits. The last proposals

emphasize correct design, construction, and maintenance to improve classroom interior quality.

Misnan et al. [16] built a sustainable water monitoring system with IoT technologies for UiTM Pasir Gudang to handle campus overflow. They discovered that their method allows anyone to check the water quality in that area from anywhere. Based on the characteristics of the characteristics of water data, the designed system monitors water parameters efficiently. Thus, early action can prevent environmental damage from bad intervention.

Zakari et al. [18] detected Pasir Gudang industrial area heat (IAH) automatically. The accuracy of IAH detection methods dominates. IAH represented 20% of the study's cool and hot spots. The mean IAH rise was 34.7 °C to 58.5 °C between the most extreme cool- and hot-spot levels (LEVEL-3) for PG in the industrial region. Zulkifli et al. [19] tried to find the best statistical approach for predicting particulate matter concentration in Pasir Gudang, Johor. Modelling and forecasting daily maximum particulate matter concentrations uses Multiple Linear Regression, Principal Component Regression, and Time Series Analysis. Multiple Linear Regression anticipates future concentrations best, followed by Principal Component Regression, and the time series model least accurately.

4.3. Environmental and pollution aspects

Environmental contamination, accidents, and health concerns can result from improper handling of hazardous waste [4]. Ibrahim et al. [4] examined the health effects of illicit chemical dumping on children in Pasir Gudang, Malaysia. A real-world scenario where measurement of chemical contamination was impossible was used to determine the danger of health impacts. On 6 March 2019, tons of hazardous trash were illegally dumped into Kim Kim River, Pasir Gudang, Malaysia. Benzene, acrolein, acrylonitrile, hydrogen chloride, methane, toluene, xylene, ethylbenzene, and d-limonene were detected. Chemical contamination caused respiratory illness in 975 nearby students. They found that more effective rules and preventative measures are needed to safeguard human health, especially children, from inappropriate hazardous waste disposal.

Chemically hazardous contamination in the Pasir Gudang industrial area of Johor Malaysia was described by Ismail et al. [5]. It covered health symptoms, child psychology, and chemical detection using biomarkers and monitoring devices. Methods: They found seven substances associated with this incidence in their literature review: methane, hydrogen chloride, acrylonitrile, acrolein, benzene, xylene, and methyl mercaptan. These compounds are mostly produced industrially and break down quickly with other chemicals and sunshine. These compounds cause headaches, nausea, vomiting, breathing problems, eye discomfort, chest tightness, and wheezing when inhaled. They found that industrial chemicals can mix with other compounds or rays to release hazardous gases that cause acute health problems.

Desa et al. [10] evaluated and explained massively complicated data for 32 parameters from 25 sample stations across 20 rivers in Pasir Gudang, encompassing 1500 observations from 2015 to 2019. They found that multivariate methods can detect geographical water features and pollution sources. The findings of this study may help

Pasir Gudang lawmakers manage waterways. Zulkifli et al. [11] examined Pasir Gudang tap water samples' pH and temperature. The pH value was compared to the recommended 6.5–8.5 range for tap and drinking water. Within the pH and temperature ranges of 6.00 to 8.65 and 19.20 to 32.00 °C, respectively, observed values vary significantly. Statistically significant differences exist in pH values between sample locations ($t_{4,145} = 44.79$, $p < 0.05$). Most intriguingly, tap water samples near the industrial Pasir Gudang area had considerable pH and temperature impacts. According to Mahat et al. [12], a substantial ($p < 0.05$) and strong relationship ($r = 0.787$) between Pb content in *P. viridis* mussel and surface seawater suggests its potential use for inferring Pb concentrations. Since both the computed target hazard quotient and hazard index for Pb and Cd exceeded 1, eating *P. viridis* mussels from this rearing location may harm humans.

Ibrahim et al. [20] assessed Pasir Gudang Municipality's green spaces and promoted methods to enhance their utilisation to improve inhabitants' quality of life. Their study categorised Pasir Gudang's green spaces by size, purpose, usage, quality, area, accessibility, and facilities. Their analysis also indicated a possible access network that would make all green space locations more accessible to inhabitants, improving their quality of life. Abas and Din [22] used lichen transplanting to measure heavy metals in Pasir Gudang, Johor. *Usnea misaminensis* from the isolated National Park of Endau Rompin, Johor, has been transferred to the city. After 4–6 weeks after lichen transplanting, the greatest concentration of iron (Fe) was 84.43 µg/g, whereas the highest concentration of chromium (Cr) was 0.66 µg/g. Their findings revealed that Pasir Gudang's increased number of passenger automobiles will increase heavy metal pollution.

4.4. Social aspect

Latiff et al. [21] examined Pasir Gudang teenagers' depression, anxiety, and stress symptoms and causes. In Pasir Gudang, Johor, Malaysia, 10 secondary schools' students were sampled using cluster sampling in cross-sectional research. They found that teenage sadness, anxiety, and stress were impacted by sociodemographics and parents. Age, gender, and parental attachment were important predictors in the current study and should be the focus of future investigations to minimise psychiatric illnesses among Pasir Gudang adolescents. Syed Mahdzar [2] suggested design measures and implementations by relating social, socio-physical, and spatial (syntactical) factors to Pasir Gudang City Centre (PGCC) street behaviour and use. In November 1986, Abdul Majid and Zain [6] examined the oral health of 198 Antara Steel, Pasir Gudang, and Johor manufacturing workers. The sample included 107 smokers (54%), 41 of whom had significant nicotine stains (20.7%). A soft tissue examination revealed 111 (56%) recurring aphthous ulcers and 15 (7.6%) herpes labialis. Five participants (2.5%) had denture stomatitis, although other soft tissue infections were rare.

Ahmad et al. [7] sought to improve Pasir Gudang community emergency response by creating a theoretical framework. Their theoretical framework would help managers understand community-based emergency response and develop effective methods. Tajik et al. [8] examined eating habits, stress, and depression in teenagers in Pasir Gudang, Malaysia. Teens' bad eating habits affect mental health, according to

their results. Mental health should be improved by targeted education. Ahmad et al. [17] identified Pasir Gudang's community-based hazardous gas response components. The emergency response construct has a logit mean of 0.00 and a score mean of 3.67–5.00. This shows that major building elements are widely agreed upon. Yahya et al. [26] assessed Pasir Gudang healthcare workers' CBRNE crisis readiness. They suggested that CBRNE preparation measures would raise awareness forever. This study would allow management to assess the readiness of other important healthcare professionals or first responders and improve healthcare staff catastrophe service.

4.5. Economic aspect

The green industry has been seen as a crucial component in achieving enhanced sustainability [9]. The study by Teh et al. [9] aims to analyse the elements that influence the establishment of industrial symbiosis in different nations to facilitate the growth of such networks in Pasir Gudang. The results indicated that several factors, such as institutional framework, legal and regulatory systems, financial resources, awareness and capacity-building initiatives, technological advancements, research and development efforts, information availability, collaborative efforts, market conditions, geographical closeness, environmental concerns, and industry structure, together influence the establishment of industrial symbiosis.

Sabeen et al. [29] sought to ascertain the financial expenditure associated with solid waste management in Pasir Gudang, Johor, Malaysia. A one-year composition study was done in the Tanjung Langsat Landfill. The present municipal solid waste management was assessed to determine the transportation costs from different areas within the municipality to the Tanjung Langsat dump. Their suggested strategy could decrease solid waste management expenses from RM 7,130,884.00 to RM 6,093,872.00, resulting in a cost savings of RM 1,037,012.00, or a 14.5% annual cost reduction. This might potentially extend the longevity of the landfill in the studied location.

4.6. Knowledge gaps

This gives a holistic overview of the past research based on keywords' co-occurrences with 'Pasir Gudang' (**Figure 5**). The analysis reveals a discernible prominence reflecting three principal domains of investigation, namely three significant clusters that can be identified based on visualization in **Figure 5** (top panel): a) human-related studies; b) risk assessments, male and female-related studies, water quality, depression, and stress; c) adolescents' behaviors, adolescents' diseases, body weight, and body mass. Many researchers [1–28] have recently focused on studies such as water monitoring, dumping, children, acrolein, methane, slurry, large-scale solar, etc. (**Figure 5**; bottom panel).

However, topics on conservation, protection, or pollution recovery/bioremediation, mostly recently on environment, social, and governance (ESG), are not mentioned based on all the literature reviewed and visualized (**Figure 5**). Therefore, these could be the knowledge gaps for the near future studies when rivers near Pasir Gudang Industrial Area, such as Kim Kim River, have always been categorized as 'polluted' status since 1980 [12,29].

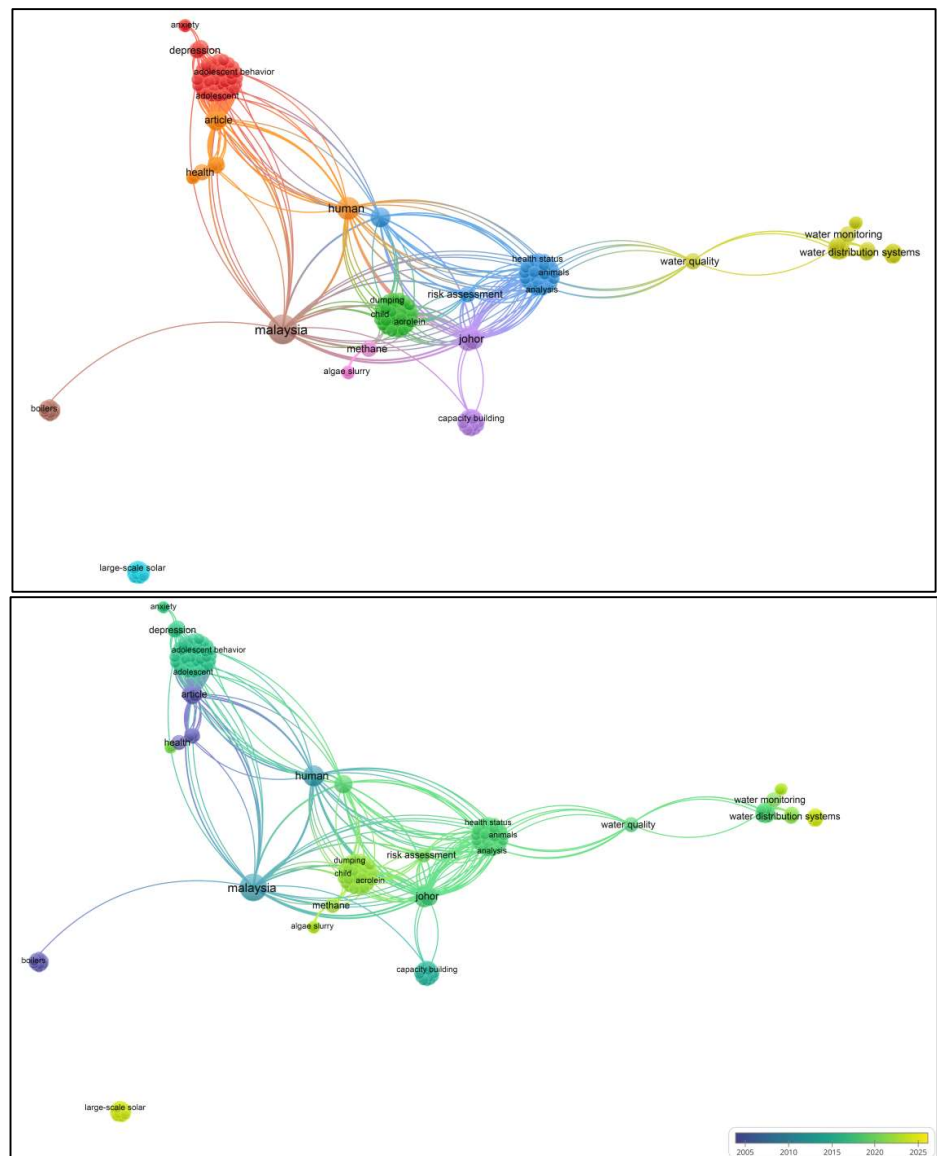


Figure 5. A bibliometric analysis of research themes on ‘Pasir Gudang’. Top Panel: Visualization of the paper network confirming the main themes of research. Bottom Panel: Evolution of research trends between 1983 and 2023 based on Scopus database. The colours in the top panel indicate the themes of research that the papers are being discussed, while in the bottom panel the colours indicate the year of publication. N = 28 papers.

5. Conclusion

In sum, the present review identified that the published papers are mainly categorized into hydrology, monitoring and forecasting, social, economic, and environmental themes. However, topics on conservation, protection, or pollution recovery/ bioremediation, most recently on ESG. Therefore, these are considered knowledge gaps that are highly recommended in future studies at and around the active Pasir Gudang industrial area.

Conflict of interest: The authors declare no conflict of interest.

References

1. Lee JH, Jeevaragam P, Max Mulwan NK, et al. Water Distribution System Modelling in Pasir Gudang, Johor with EPANET. In: Harun S, Othman IK, Jamal MH (editors). Proceedings of the 5th International Conference on Water Resources (ICWR)–Volume 1. Springer; 2022. pp. 283-294. doi: 10.1007/978-981-19-5947-9_24
2. Syed Mahdzar SS. Streets for people: Sustaining accessible and sociable streets in Pasir Gudang City Centre. In: Kim YO, Park HT, Seo KW (editors). Proceedings of the Ninth International Space Syntax Symposium. Sejong University Press; 2013.
3. Sahrani FK, Ibrahim Z, Yahya A, Aziz M. Isolation and identification of marine sulphate-reducing bacteria, *Desulfovibrio* sp. and *Citrobacter freundii* from Pasir Gudang, Malaysia. Sains Malaysiana. 2008, 37(4): 365-371.
4. Ibrahim MF, Hod R, Toha HR, et al. The Impacts of Illegal Toxic Waste Dumping on Children's Health: A Review and Case Study from Pasir Gudang, Malaysia. International Journal of Environmental Research and Public Health. 2021, 18(5): 2221. doi: 10.3390/ijerph18052221
5. Ismail SNS, Abidin EZ, Rasdi I. A case study of Pasir Gudang chemical toxic pollution: A review on health symptoms, psychological manifestation and biomarker assessment. Malaysian Journal of Medicine and Health Sciences. 2020, 16: 175-184.
6. Abdul Majid Z, Zain RB. The dental health of factory workers in Pasir Gudang, Johor (Malaysia). Dental Journal of Malaysia. 1988, 10(1): 38-41.
7. Ahmad NA, Kidam K, Mohsin R. A Community-Based Emergency Response Management in Pasir Gudang, Johor: Theoretical Framework. IOP Conference Series: Materials Science and Engineering. 2020, 808(1): 012021. doi: 10.1088/1757-899x/808/1/012021
8. Tajik E, Latiffah AL, Awang H, et al. Unhealthy diet practice and symptoms of stress and depression among adolescents in Pasir Gudang, Malaysia. Obesity Research & Clinical Practice. 2016, 10(2): 114-123. doi: 10.1016/j.orcp.2015.06.001
9. Teh BT, Ho CS, Matsuoka Y, et al. Determinant factors of industrial symbiosis: Greening Pasir Gudang industrial park. IOP Conference Series: Earth and Environmental Science. 2014, 18: 012162. doi: 10.1088/1755-1315/18/1/012162
10. Desa MS, Sulaiman MA, Rajan S. Water Quality Assessment and Characterization of Rivers in Pasir Gudang, Johor via Multivariate Statistical Techniques. Pertanika Journal of Science and Technology. 2022, 31(1): 495-510. doi: 10.47836/pjst.31.1.29
11. Zulkifli SN, Rahim HA, Subha NA. Analysis of Bacterial Contaminant in Pasir Gudang, Johor Tap Water Supply–Varies pH Value Observation. International Journal of Engineering. 2018, 31(8). doi: 10.5829/ije.2018.31.08b.38
12. Mahat NA, Muktar NK, Ismail R, et al. Toxic metals in *Perna viridis* mussel and surface seawater in Pasir Gudang coastal area, Malaysia, and its health implications. Environmental Science and Pollution Research. 2018, 25(30): 30224-30235. doi: 10.1007/s11356-018-3033-8
13. Rahman NHA, Hussin MZ, Sulaiman SI, et al. Univariate and multivariate short-term solar power forecasting of 25MWac Pasir Gudang utility-scale photovoltaic system using LSTM approach. Energy Reports. 2023, 9: 387-393. doi: 10.1016/j.egyr.2023.09.018
14. Mohamad Nor Zaki NK, Ahmad Bari NA. A Study on the indoor air quality (IAQ) at primary school in Industrial Area: A case study to Sekolah Kebangsaan Pasir Gudang 3 (SKPG3). IOP Conference Series: Earth and Environmental Science. 2022, 1067(1): 012010. doi: 10.1088/1755-1315/1067/1/012010
15. Eric J. Paka and Pasir Gudang: Fast track combined cycles for Malaysian IPP. Turbomachinery International. 1996, 37(2): 28-30.
16. Misnan MF, Thamrin NM, Nik NNL. Smart Sustainable Water Monitoring System via Internet of Things (IoT) for Water Retention Pond UiTM Cawangan Johor, Kampus Pasir Gudang. International Journal of Sustainable Construction Engineering and Technology. 2022, 13(2). doi: 10.30880/ijscet.2022.13.02.001
17. Ahmad NA, Kidam K, Mohsin R. Appropriate Community-Based Emergency Response Elements for Toxic Gas Release in Pasir Gudang, Johor. In: Mohamed Noor N, Sam ST, Abdul Kadir A (editors). Proceedings of the 3rd International Conference on Green Environmental Engineering and Technology. Springer; 2022. pp. 3-8. doi: 10.1007/978-981-16-7920-9_1

18. Zakari MD, Hashim M, Hassan N. Mapping and detection of hotspot sources from industrial area heat (IAH) using aerial and satellite-based TIR data in Pasir Gudang. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*. 2023, XLVIII-4/W6-2022: 415-422. doi: 10.5194/isprs-archives-xxviii-4-w6-2022-415-2023
19. Zulkifli NM, Ezzadin NWS, Awang N. Performance of Several Statistical Methods in Forecasting Particulate Matter Concentrations in Pasir Gudang, Johor. In: Abdul Karim SA (editor). *Intelligent Systems Modeling and Simulation II: Machine Learning, Neural Networks, Efficient Numerical Algorithm and Statistical Methods*. Springer; 2022. pp. 479-493. doi: 10.1007/978-3-031-04028-3_31
20. Wan Ibrahim WY, Long A, Permana AS. Green space audits on its accessibility in Pasir Gudang. *Planning Malaysia Journal*. 2013, 11(2). doi: 10.21837/pmjournal.v11.i2.115
21. Latiff LA, Tajik E, Ibrahim N, et al. Psychosocial problem and its associated factors among adolescents in the secondary schools in Pasir Gudang, Johor. *Malaysian Journal of Medicine and Health Sciences*. 2017, 13(1): 35-44.
22. Abas A, Din L. Heavy Metal Concentration Assessment Using Transplanted Lichen *Usnea misaminensis* at Pasir Gudang, Johor. *IOP Conference Series: Earth and Environmental Science*. 2020, 549(1): 012063. doi: 10.1088/1755-1315/549/1/012063
23. Ghafar AA, Said I, Fauzi AM, et al. Comparison of leaf area index from four plant species on vertical greenery system in Pasir Gudang, Malaysia. *Pertanika Journal of Science and Technology*. 2020, 28(2): 735-748.
24. Thakar VS, Patil BM, Murthy KKG. Mathematical modelling of hydrothermal recirculation for Pasir Gudang power station, Malaysia. In: *Proceedings of the Conference on Waste Heat Management and utilization*; 12 May 1981; Miami, FL, USA. pp. IV.A.51-IV.A.53209-221.
25. Siddique NI, Zaied BK, Bin Ibrahim Mohd Z, et al. Kinetic Modeling of Peroxydisulfate Pre-Treatment of Algae Slurry (Pasir Gudang, Malaysia) for Increasing Methane Generation from Anaerobic Digestion: Fertilizer Recovery. *Asian Journal of Chemistry*. 2022, 34(10): 2725-2731. doi: 10.14233/ajchem.2022.23809
26. Yahya NYB, Md Ali AHB, Rahmat RB, et al. Preparedness towards Chemical, Biological, Radiological, Nuclear, and Explosive (CBRNE) threats among healthcare personnel in Pasir Gudang, Johor, Malaysia. *International Journal of Disaster Risk Reduction*. 2022, 82: 103235. doi: 10.1016/j.ijdrr.2022.103235
27. Mohammad Z, Bakri A, Januddi FS, Effendy S. Fundamental Study of Energy Control System Lockout and Tagout (LOTO) Implementation in Manufacturing Industry at Pasir Gudang, Johor. *Test Engineering and Management*. 2019, 81(11-12): 5941-944.
28. Sabeen AH, Ngadi N, Noor ZZ. Minimizing the cost of municipal solid waste management in Pasir Gudang Johor Malaysia. *Journal of Materials and Environmental Science*. 2016, 7(5): 1819-1834.
29. Abdullah MH, Halim H, Rahman R, et al. Incidents of Poisonous Gas Spreading in Pasir Gudang, Johor, Malaysia: Responsibilities, Roles and Social Impacts on Communities. *Resmilitaris*. 2023, 13(1): 3660-3671.
30. Mohiyaden HA, Sidek LM, Noh SM, et al. Water quality index analysis in Kim-Kim River: Effects of Covid-19 movement control order. *IOP Conference Series: Earth and Environmental Science*. 2023, 1143(1): 012002. doi: 10.1088/1755-1315/1143/1/012002
31. Mansor AA, Abdullah S, Dom NC, et al. Three-Hour-Ahead of Multiple Linear Regression (MLR) Models for Particulate Matter (PM10) Forecasting. *International Journal of Design & Nature and Ecodynamics*. 2021, 16(1): 53-59. doi: 10.18280/ijdne.160107
32. Ellegaard O, Wallin JA. The bibliometric analysis of scholarly production: How great is the impact? *Scientometrics*. 2015, 105(3): 1809-1831. doi: 10.1007/s11192-015-1645-z
33. van Eck NJ, Waltman L. Software survey: VOSviewer, a computer program for bibliometric mapping. *Scientometrics*. 2009, 84(2): 523-538. doi: 10.1007/s11192-009-0146-3
34. Guz AN, Rushchitsky JJ. Scopus: A system for the evaluation of scientific journals. *International Applied Mechanics*. 2009, 45(4): 351-362. doi: 10.1007/s10778-009-0189-4
35. Morbidelli R, Saltalippi C, Dari J, Flammini A. A Review on Rainfall Data Resolution and Its Role in the Hydrological Practice. *Water*. 2021, 13(8): 1012. doi: 10.3390/w13081012
36. Fabian PS, Kwon HH, Vithanage M, Lee JH. Modelling, challenges, and strategies for understanding impacts of climate extremes (droughts and floods) on water quality in Asia: A review. *Environmental Research*. 2023, 225: 115617. doi: 10.1016/j.envres.2023.115617

Review

Anthropological strategies for successful Christian missionary endeavors amidst poverty escalation in Africa

Akinyemi Oluwafemi Alawode

Head of Department of Intercultural Studies, Faculty of Theological Studies, The Nigerian Baptist Theological Seminary, Ogbomoso 210251, Nigeria; akinalawode@gmail.com

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Abstract: Poverty and hunger have become global crises, especially in Africa. African political leaders have continued to mismanage public resources, while many have embezzled public funds. Some have misappropriated public funds and borrowed senselessly from the West, making it difficult for them to dissociate themselves from the dictates of Western powers. Another factor that has impoverished Africa is intertribal war, caused mainly by leadership negligence because of their political calculations. Other problems that have contributed to the escalating poverty level in Africa are political instability, economic downturn, and religious intolerance. Despite the poverty crisis in Africa, the church has remained proactive in alleviating poverty there. The church has been missional in its approach, but with its missionaries' efforts, it has had to become strategic in contemporary times to record successes in its missions' endeavours in Africa, especially in Nigeria. Therefore, this paper attempts to explain the anthropological strategies that mission agencies and missionaries employ to record success in the face of poverty escalation in Africa. This will be achieved by explaining the concept of poverty in Africa, historically examining missions' success in Africa, and identifying anthropological strategies employed by missionaries in Africa despite the escalating level of poverty in Africa. This study reveals strategies for mission success to ensure missionaries of different denominations are aware of previous achievements and want to do more.

Keywords: anthropological strategy; missions' success; poverty escalation; hunger; political leaders; Africa

1. Introduction

According to Reid [1], Africa is a continent of remarkable diversity, encompassing many cultures, languages, and socio-economic conditions. It is also a continent where Christianity has a significant presence, with millions of adherents across various denominations. However, the coexistence of Christianity and deep-seated poverty in many African regions poses unique challenges to Christian missionary endeavours. In this context, anthropology, the study of human societies and cultures, offers valuable tools and perspectives to enhance the effectiveness of missionary efforts. This article explores anthropological strategies for successful Christian missionary endeavours amidst the escalation of poverty in Africa.

Moreover, the confluence of Christian missionary endeavours and the pervasive challenges of poverty in Africa form a complex and multifaceted terrain that demands strategies for effective intervention. This academic exploration delves into the intersections of anthropology and Christian missionary work, aiming to discern and implement strategies to cross over the complicated socio-cultural contexts in which poverty manifests. Africa, with its rich diversity of cultures, traditions, and economic

landscapes, presents a unique challenge and opportunity for missionaries seeking to address poverty in a culturally sensitive, sustainable, and transformative manner.

Pawlikova-Vilhanva [2] opines that the historical roots of Christian missionary work in Africa are deeply intertwined with endeavours to alleviate suffering and bring positive societal change. From the early missions associated with European colonialism to contemporary initiatives led by indigenous and international organisations, the Christian mission has been a constant presence in the African narrative. However, the persistently escalating challenges of poverty in various regions necessitate re-evaluating missionary strategies, specifically focusing on the insights offered by anthropological perspectives.

As a discipline, anthropology provides a holistic framework for understanding the intricate web of cultural, social, economic, and environmental factors contributing to African poverty. By embracing an anthropological lens, Christian missionaries can engage in a more empathetic and culturally informed dialogue with the communities they seek to serve. This article explores the potential of anthropological strategies to enhance the effectiveness of Christian missionary endeavours in addressing poverty, fostering community development, and promoting sustainable change.

As we embark on this exploration, it is essential to recognise the delicate balance that must be struck between the universal principles of Christian mission and the diverse cultural contexts of Africa. This discussion seeks to transcend the dichotomy of universalism and cultural relativism, envisioning a collaborative approach that integrates Christian values with anthropological insights to uplift communities grappling with poverty. By examining historical precedents, contemporary challenges, and the evolving role of anthropology in missionary work, the author aims to contribute to a discourse that inspires innovative and culturally sensitive strategies for the pursuit of social justice and holistic well-being in the African context.

2. Concept of poverty in Africa

Desarrollo [3] says poverty in Africa extends beyond narrow economic definitions, encompassing a range of interconnected factors that impact individuals, communities, and entire nations. This research explores the historical roots of poverty on the continent, the impact of colonial legacies, and the contemporary challenges perpetuating and exacerbating poverty in diverse African contexts. Poverty in Africa is inherently multidimensional, encompassing economic, social, cultural, and political dimensions. This section examines various conceptual frameworks, such as the capability approach and the human development index, to provide a holistic understanding of poverty. By acknowledging the interconnectedness of factors such as education, health, access to resources, and governance, this article seeks to capture the complexity of poverty in Africa.

Moreover, Gareth [4], in his view, says the historical context of poverty in Africa is shaped by centuries of external influences, including the transatlantic slave trade and European colonialism. The researcher analyses the lasting impact of colonial legacies on economic structures, resource distribution, and social dynamics. Understanding the historical roots of poverty is essential for formulating effective strategies that address its contemporary manifestations. Contemporary challenges

contribute to the persistence of poverty in Africa. The author examines population growth, climate change, political instability, and globalisation, exploring how these elements create and perpetuate poverty. Special attention is given to structural inequalities, corruption, and inadequate infrastructure in shaping Africa's current poverty landscape. Also, cultural dynamics play a crucial role in shaping the experience of poverty in Africa. This research investigates how cultural factors, including traditional norms, gender roles, and community structures, intersect with economic and social aspects to influence the manifestations and perceptions of poverty. Understanding these cultural dynamics is essential for designing contextually relevant interventions. The researcher studies potential pathways to progress in addressing poverty in Africa, and this should be done through synthesising insights from various disciplines, including economics, sociology, and anthropology, through which this paper suggests economic growth, social empowerment, and policy interventions as part of the ways to break the poverty cycle in Africa.

3. Dimensions of poverty in Africa

Lawson et al. [5] discovered that poverty in Africa is a multifaceted and deeply rooted challenge that transcends conventional economic metrics. While economic indicators remain fundamental in assessing material deprivation, poverty in the African context extends far beyond financial insufficiency. This article section sets the stage for a comprehensive exploration of poverty, elucidating its economic, social, and cultural dimensions in Africa. By unravelling the complexities embedded in these dimensions, we aim to provide an understanding of poverty that can inform more holistic and contextually relevant strategies to alleviate poverty.

Economic dimensions: Economic poverty in Africa manifests as insufficient income, limited resource access, and economic vulnerability. The continent's economic landscape is marked by disparities in wealth distribution, unequal access to employment opportunities, and the prevalence of informal economies. Through economic dimensions, the researcher noted the challenges individuals and communities face in securing necessities such as food, shelter, and healthcare. The research pointed out that consumption poverty will also present once there is income poverty in an individual's or community's life.

Social dimensions: Abramo et al. [6] opine that beyond monetary considerations, poverty in Africa exhibits complex social dimensions encompassing education, healthcare, and social mobility. Limited access to quality education perpetuates intergenerational cycles of poverty, while inadequate healthcare services exacerbate health disparities. Social exclusion, discrimination, and unequal opportunities further compound the social aspects of poverty. This section examines the interconnectedness of these social dimensions, shedding light on how they contribute to the broader experience of poverty in diverse African communities.

Cultural dimensions: Idang [7] says cultural factors play significant roles in shaping the experience of poverty in Africa. Traditional norms, values, and community structures influence how individuals and societies steer economic challenges. Moreover, cultural resilience can be a coping mechanism and a source of strength in times of adversity. To overcome the cultural dimensions of poverty, individuals and

communities must understand poverty's economic-social factors and local contexts, belief systems, and community dynamics to develop effective poverty alleviation strategies.

The interconnectedness of dimensions: Poverty's economic, social, and cultural dimensions are intricately interconnected, creating challenges that demand holistic approaches. Indeed, these dimensions interplay, and improvements in one area can positively impact others. Conversely, neglecting any dimension may undermine efforts to address poverty comprehensively. Understanding the dynamic relationships between these dimensions is crucial for formulating effective and sustainable interventions.

The context of Africa: Alkire et al. [8] conclude that Africa's diverse and rich tapestry of cultures, histories, and economies necessitates a context-specific approach to addressing poverty. This section emphasises the need to move beyond generic definitions of poverty and acknowledges the unique challenges and opportunities on the continent. By situating poverty within the African context, we can develop strategies that resonate with the lived experiences of diverse communities; exploring the definitions of poverty in Africa sets the foundation for a multidimensional analysis. By recognising the economic, social, and cultural dimensions of poverty, the author embarks on a journey to unravel the complexities that underlie the pervasive challenge of poverty in Africa. Through this understanding, the researcher tries to contribute to the development of targeted and effective interventions that address poverty in all its dimensions on the African continent.

4. Statistical analyses of poverty escalation in Africa: Unravelling trends, patterns, and implications

Dyer [9] asserted that poverty, a persistent challenge in Africa, has wide-ranging implications for the continent's development and the well-being of its diverse populations. This research embarks on an empirical journey, employing statistical analyses to dissect the complexities surrounding the escalation of poverty in Africa. This study aims to contribute to understanding the multifaceted factors driving poverty escalation in the region by scrutinising trends, identifying patterns, and assessing the implications of poverty data. Africa's economic and demographic landscape is rapidly evolving, making it imperative to employ rigorous statistical analyses to comprehend the intricate dynamics of poverty escalation. Statistical methods offer a systematic and evidence-based approach to uncovering trends over time, examining disparities across regions, and identifying key determinants contributing to poverty's persistence or intensification. This study recognises the urgency of such analyses in informing targeted interventions and policy decisions aimed at poverty alleviation.

This research delves into historical and contemporary trends in poverty incidence across the African continent. By harnessing statistical tools, the author aims to identify shifts in poverty rates over time, understanding whether the region is making progress or facing challenges in reducing the prevalence of poverty. The researcher examines national and sub-national data to elucidate variations in poverty trends and their correlation with broader economic and social developments since individual development will later become national development.

Demographic dimensions: Ferreira *et al.* [10] states that poverty is not a monolithic phenomenon; its impact varies across demographic groups. The research assesses how poverty affects different age groups, genders, and ethnicities. Poverty is a pervasive and complex issue that affects individuals and communities across various age groups, genders, and ethnicities. The impact of poverty is multifaceted, influencing various aspects of life, including access to education, healthcare, employment opportunities, and overall well-being. Here, the researcher explores how poverty manifests differently among different demographic groups:

Age groups: Children: Evans and Kim [11] stated that poverty profoundly affects children's physical and cognitive development. Lack of access to proper nutrition, healthcare, and educational resources can lead to long-term consequences, hindering their potential and perpetuating cycles of poverty.

Working-age adults: Poverty among adults often translates into limited job opportunities, inadequate wages, and precarious employment conditions. Not securing employment can result in financial instability, housing insecurity, and family support challenges.

Elderly Population: Older individuals facing poverty may experience difficulties accessing healthcare and may be more vulnerable to inadequate housing and social isolation. Limited financial resources can compromise their ability to meet healthcare needs and maintain a decent quality of life in retirement.

Genders: Women: Women often bear a disproportionate burden of poverty due to factors such as gender wage gaps, limited access to education, and discriminatory cultural norms. Poverty can restrict women's access to healthcare, expose them to higher levels of gender-based violence, and hinder their ability to achieve economic independence [12]. Men: While men also experience the impact of poverty, gender norms may influence the types of challenges they face. For instance, societal expectations regarding traditional male roles as primary earners can intensify feelings of inadequacy and stress when facing economic hardship.

Ethnicities: Minority and marginalised groups: Certain ethnicities and minorities may face systemic barriers contributing to higher poverty rates [13]. Discrimination, limited access to education and employment opportunities, and unequal treatment within societal structures can exacerbate poverty among these populations.

Indigenous communities: Indigenous populations may confront unique challenges, including marginalisation, loss of traditional lands, and inadequate access to essential services. These factors contribute to higher poverty rates among indigenous communities.

Bieri [14] stated that understanding the differential impact of poverty on various demographic groups is crucial for developing targeted and effective interventions. Policies and programs aimed at poverty alleviation should be sensitive to the specific needs and challenges children of different age groups, genders, and ethnicities face. Additionally, promoting gender equality, addressing systemic discrimination, and fostering inclusive economic development are essential components of comprehensive strategies to combat poverty across diverse communities. By recognising and addressing these variations, societies can work towards building more equitable and resilient structures that uplift individuals and groups affected by poverty.

5. Anthropological strategies employed by missionaries in Africa

Anthropological strategies employed by African missionaries reflect a dynamic and adaptive approach to engaging with diverse cultures, understanding local contexts, and facilitating effective communication. These strategies draw on principles of cultural anthropology to bridge the gap between missionary objectives and the intricate socio-cultural landscapes of African communities. Here are some vital anthropological strategies employed by missionaries:

Cultural immersion and participant observation: Caughey [15] says missionaries often engage in cultural immersion by living among the communities they aim to serve, and this involves participating in daily activities, observing rituals, and experiencing the community's way of life. Participant observation allows missionaries to gain firsthand insights into local customs, belief systems, and social structures.

Language acquisition: Learning the local language is a fundamental anthropological strategy employed by missionaries. Language proficiency is essential for effective communication, building trust, and understanding the nuances of cultural expressions. Missionaries invest time and effort in acquiring linguistic skills to engage meaningfully with community members.

Cultural sensitivity and respect: Nkomazana and Senzokuhle [16] observed that cultural sensitivity is at the core of anthropological strategies employed by missionaries. Recognising and respecting local customs, traditions, and taboos is crucial for building community trust. Missionaries strive to avoid imposing their cultural values and instead seek to understand and appreciate the perspectives of the communities they serve.

Customisation of religious practices: Acquah [17] confirmed that missionaries often adapt religious practices to align with local cultural norms; this may involve incorporating indigenous music, art, and symbols into worship ceremonies, making Christianity more relatable and inclusive. The goal is to convey the universality of religious principles while respecting and integrating local cultural expressions.

Collaborative approaches and community involvement: Successful missionary endeavours recognise the importance of collaboration with local communities. Missionaries work alongside community members, involving them in decision-making processes and development initiatives, since a tree cannot make a forest. This collaborative approach ensures that interventions are contextually relevant and address the specific needs and aspirations of the community.

Addressing socio-economic issues: Lee [18] described anthropological strategies employed by missionaries as something that extends beyond the spiritual realm to address socio-economic challenges. Missionary initiatives may include establishing schools, healthcare facilities, and vocational training programs to uplift communities economically while respecting local cultural contexts because it is better to teach the indigenes how to fish instead of giving them fish each time they are in need for them to be self-sufficient instead of depending on anyone or an organisation for their livelihood.

Storytelling and oral tradition: The importance of oral tradition in many African cultures cannot be overemphasised, which is why missionaries often employ storytelling to convey religious messages. This approach aligns with local

communication styles and resonates with communities valuing oral narratives to transmit knowledge and values.

Adaptation of evangelistic techniques: According to Graham [19], missionaries may adapt evangelistic techniques to align with cultural practices; this could involve incorporating drama, music, or dance into evangelistic activities, making them more engaging and culturally attractive.

Respect for indigenous spirituality: Anthropological strategies emphasise respect for indigenous spiritual beliefs. Missionaries seek common ground and points of connection between Christian teachings and elements of indigenous spirituality, promoting a more inclusive and culturally sensitive approach [20].

Long-term cultural integration: Sjaak [21] observed that anthropological strategies are often framed with a long-term perspective. Missionaries recognise that cultural integration and acceptance of religious teachings may take time. A long-term commitment to a community allows missionaries to build meaningful relationships and create lasting impact.

By employing these anthropological strategies, missionaries aim to overcome the difficulties of cultural diversity, fostering a more inclusive and respectful approach to their work in Africa. These strategies contribute to developing a mutually enriching dialogue between missionaries and their communities, recognising the value of cultural diversity in pursuing shared goals.

6. Cultural sensitivity and adaptation in missionary work: Navigating cross-cultural dynamics

Lutz [22] affirmed that cultural sensitivity and adaptation are paramount in missionary work, emphasising a profound understanding of diverse cultural contexts to foster effective communication, build trust, and promote meaningful engagement. This part of the article delves into the significance of cultural sensitivity and adaptation within missionary endeavours, examining their role in building bridges across cultural divides and achieving successful outcomes. Because cultural sensitivity in missionary work entails a deep appreciation and awareness of the cultural norms, values, and customs of the communities being served, this awareness is crucial in establishing respectful and authentic relationships, minimising the risk of misunderstandings, and acknowledging the dignity and agency of those engaged in the missionary process. Also, cultural sensitivity builds trust by demonstrating respect for local traditions. Missionaries who embrace and honour the cultural fabric of a community create a foundation of trust, paving the way for open dialogue and collaboration. Cultural sensitivity is also instrumental in avoiding cultural imperialism, that is, the imposition of one's cultural values upon another. Missionaries strive to understand and appreciate the diversity of local cultures, recognising the validity of different worldviews and spiritual practices.

Cultural adaptation: Duncan [19] states that cultural adaptation involves adjusting one's behaviour, communication style, and practices to align with the community's cultural norms. The purpose is to ensure that missionary efforts are relevant, relatable, and resonant within the local context. Effective communication is at the centre of cultural adaptation. Missionaries invest time and effort in learning local

languages to communicate more authentically, reinforcing a commitment to understanding and being understood within the community. Moreover, successful missionaries adapt religious practices to incorporate indigenous elements, making Christianity more accessible and attractive to indigenous peoples by integrating local music, art, and symbols into worship, creating a synthesis that reflects the community's cultural identity. For example, the Jesuit Missions in China (16th–17th Centuries): Jesuit missionaries in China exemplified cultural sensitivity and adaptation by integrating Confucian values into their teachings. This approach facilitated dialogue and mutual understanding, demonstrating the effectiveness of adapting religious messages to align with local philosophies. Equally important is the Work of Mother Teresa in India (20th Century): Mother Teresa's missionary work in India showcased cultural sensitivity through her deep respect for Hindu and Muslim traditions. Her compassionate approach, focused on alleviating suffering without imposing religious conversion, stressed the importance of adapting to the cultural context. Cultural sensitivity and adaptation are not just strategies but ethical imperatives in missionary work. As missionaries navigate the complex terrain of diverse cultures, embracing and adapting to local contexts ensures the effectiveness of their efforts and fosters a genuine connection with the communities they serve. In a world marked by cultural diversity, missionaries who embody cultural sensitivity and adaptation contribute to building bridges that transcend religious, linguistic, and cultural boundaries.

7. Examples of Christian missionary initiatives effectively addressed poverty through anthropological strategies

Marlowe [23] opines that successful missionary efforts testify to the transformative power of cultural understanding, community engagement, and strategic interventions. Through the lens of anthropology, missionaries have approached diverse communities with sensitivity, adapting their methods to align with local cultures. An example is the work of Albert Schweitzer in Gabon (20th century). Albert Schweitzer, a theologian, philosopher, and medical missionary, exemplifies successful missionary efforts. His work in Gabon, Africa, was characterised by deep cultural immersion, linguistic proficiency, and a commitment to addressing spiritual and practical needs [24]. Schweitzer's establishment of a hospital in Lambaréné provided essential medical care and embraced local customs, earning the trust and respect of the indigenous population, as did the mission efforts of Jesuit Missions in Paraguay (17th–18th centuries). The Jesuit missions in Paraguay offer a historical example of successful missionary endeavours. Jesuit missionaries engaged with indigenous Guaraní communities, learning their languages and incorporating indigenous musical and artistic expressions into religious practices. This cultural sensitivity facilitated the establishment of thriving Christian communities that integrated indigenous traditions, contributing to a unique cultural synthesis [25].

Moreover, Christian missionary initiatives addressing poverty through anthropological strategies have proven impactful in fostering sustainable change. By understanding the cultural contexts of poverty and employing strategies rooted in anthropology, missionaries have contributed to holistic development. The following

examples highlight instances where anthropological strategies were key in poverty alleviation efforts.

Education and community development in Uganda (21st century): Christian missionaries have implemented anthropologically informed strategies to address poverty in Uganda through education and community development. Missionary organisations have focused on building schools that respect local languages and incorporate culturally relevant curricula. Missionaries have successfully empowered individuals and communities through education by engaging with the community, understanding its unique needs, and collaborating with local leaders [26]

Healthcare initiatives in Malawi (late 20th century present): Christian missionary initiatives in Malawi have employed anthropological strategies to address poverty by improving healthcare access. Missionary organisations have established clinics and hospitals, integrating traditional healing practices where applicable. Missionaries have created culturally sensitive healthcare systems that address physical and cultural well-being by training local healthcare workers and collaborating with traditional healers [27].

Microfinance and economic empowerment in Kenya (21st century): Maru and Chemjor [28] say that Christian missionaries have implemented anthropological strategies in Kenya to combat poverty through economic empowerment. Microfinance initiatives, informed by an understanding of local economic structures and social dynamics, have successfully provided small loans to individuals, particularly women. By respecting communal values and working within existing social structures, missionaries have enabled entrepreneurship and lifted families out of poverty.

The examples above demonstrate that successful missionary efforts are intricately linked to applying anthropological strategies. By respecting and understanding local cultures, languages, and traditions, missionaries can address the root causes of poverty and work collaboratively with communities to bring about positive, sustainable change. As missionaries continue to navigate the complexities of diverse contexts, these case studies offer valuable insights into the potential impact of anthropological approaches in missionary work.

8. Conclusion

In conclusion, exploring anthropological strategies in the context of Christian missionary endeavours amidst poverty escalation in Africa reveals a holistic approach that holds immense potential for positive impact. The multifaceted strategies discussed, rooted in cultural understanding, community engagement, and adaptability, exemplify the imperative for missionaries to navigate the complexities of diverse African cultures with sensitivity and respect.

The foundational principles of cultural immersion, participant observation, language proficiency, and customisation of religious practices emerged as critical components of successful missionary work. Collaborative approaches, long-term commitment, and the avoidance of cultural imperialism were underscored as essential strategies for missionaries seeking to address the pervasive challenges of poverty.

Anthropology contributes to the development of holistic approaches to addressing poverty. Instead of viewing poverty solely through an economic lens,

missionaries informed by anthropological principles recognise the interconnectedness of cultural, social, and economic factors contributing to poverty. Anthropology encourages missionaries to respect and appreciate the local worldviews and belief systems.

Anthropology provides missionaries a toolkit for navigating Africa's complex and diverse cultural landscape. It equips them with the cultural sensitivity, adaptability, and deep understanding required to establish meaningful connections, build trust, and contribute to positive and sustainable transformations within the communities they serve. In embracing the principles of anthropology, Christian missionaries can work collaboratively with African communities, fostering a shared journey toward holistic well-being and development.

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References

1. Reid MS. Imparting Biblical Theology Cross-culturally for Transformation [PhD thesis]. Bethel University; 2016.
2. Pawlková-Vilhanová V. Christian Missions in Africa and Their Role in the Transformation of African Societies. Institute of Oriental Studies, Slovak Academy of Sciences; 2007.
3. Desarrollo MY. Understanding poverty from a gender perspective. Women and Development Unit Publication; 2004.
4. Gareth A. African Economic Development and Colonial Legacies. London School of Economics and Political Science Publication; 2010.
5. Lawson D, Angemi D, Kasirye I. What Works for Africa's Poorest Children. Practical Action Publishing; 2020. doi: 10.3362/9781780448572
6. Abramo L, Cecchini S, Morales B. Social Programmes, Poverty Eradication and Labour Inclusion: Lessons from Latin America and the Caribbean. ECLAC Books; 2019.
7. Idang GE. African culture and values. *Phronimon*. 2015, 16(2): 1561-4018.
8. Alkire S, Kanagaratnam U, Suppa N. The Global Multidimensional Poverty Index (MPI) 2022 Country Results and Methodological Note. University of Oxford; 2022.
9. Dyer C. Poverty and its Relief in Late Medieval England*. *Past & Present*. 2012; 216(1): 41-78. doi: 10.1093/pastj/gts016
10. Ferreira dean F, Jolliffees M, Prydz PB. Let's Talk Development, World Bank Blog 2015. Available online: <https://blogs.worldbank.org/developmenttalk/international-poverty-line-has-just-beenraised-190-day-global-poverty-basically-unchanged-how-even> (accessed on 2 December 2023).
11. Evans GW, Kim P. Childhood poverty and health: Cumulative risk exposure and stress dysregulation. *Psychological Science*. 2013; 24(11): 1544-1554.
12. Frankema E. The colonial roots of land inequality: geography, factor endowments, or institutions? *The Economic History Review*. 2010; 63(2): 418-451. doi: 10.1111/j.1468-0289.2009.00479.x
13. Policy 21 Limited, Centre for Civil Society and Governance. A Study on Ethnic Minorities' Awareness and Satisfaction towards Selected Public Services. The University of Hong Kong; 2018.
14. Bieri S. Power and poverty. Reducing gender inequality by ways of rural employment? In: Proceedings of the FAO-IFAD-ILO Workshop on Gaps, Trends and Current Research in Gender Dimensions of Agricultural and Rural Employment: Differentiated Pathways out of Poverty; 31 March–2 April 2009; Rome, Italy.
15. Caughey JL. The Ethnography of Everyday Life: Theories and Methods for American Culture Studies. *American Quarterly*. 1982, 34(3): 222. doi: 10.2307/2712776
16. Nkomazana F, Senzokuhle DS. Missionary colonial mentality and the expansion of Christianity in Bechuanaland Protectorate, 1800 to 1900. *Journal for the Study of Religion*. 2016.
17. Acquah F. The Impact of African Traditional Religious Beliefs and Cultural Values on Christian Muslim Relations in Ghana from 1920 through the Present: A Case Study of Nkusukum-Ekumfi-Enyan area of the Central Region [PhD thesis]. University of Exeter; 2011.

18. Lee S. Faith in the Marketplace: Measuring the Impact of Church Based Entrepreneurial Approaches to Holistic Mission [PhD thesis]. School of World Mission and Evangelism, Asbury Theological Seminary; 2019.
19. Duncan GA. Inculturation: Adaptation, innovation and reflexivity an African Christian perspective. *HTS Theologiese Studies/Theological Studies*. 2014, 70(1). doi: 10.4102/hts.v70i1.2669
20. Acquah F. The Impact of African Traditional Religious Beliefs and Cultural Values on Christian Muslim Relations in Ghana from 1920 through the Present: A Case Study of Nkusukum-Ekumfi-Enyan area of the Central Region [PhD thesis]. University of Exeter; 2011.
21. Sjaak vdG. Anthropologists and Missionaries: Brothers Under the Skin. *Man*. 1990, 25(4): 588. doi: 10.1907/2803655
22. Lutz SA. Cultural Sensitivity: Importance, Competencies, and Public Relations Implications. University of Tennessee; 2017.
23. Marlowe JD. Multicultural Diversity and Missionary Team Dynamics [Master's thesis]. Acadia Divinity College; 2018.
24. Harris R. Schweitzer and Africa. *The Historical Journal*. 2016, 59(4): 1107-1132. doi: 10.1017/s0018246x16000078
25. Neumann E. The Guaraní Missions in the Jesuit Province of Paraguay, 1609–1800. *Oxford Research Encyclopedia of Latin American History*. Oxford University Press; 2019.
26. Sidonia AO, David CW. Pastoral education: The missing link in Uganda education system. *Educational Research and Reviews*. 2019, 14(7): 240-253. doi: 10.5897/err2018.3598
27. Wright J. Strengthening Mental Health Care in Southern Malawi: Contested Meanings and the Search for Culturally Embedded Approaches [PhD thesis]. University of York; 2021.
28. Maru L, Chemjor R. Microfinance Interventions and Empowerment of Women Entrepreneurs Rural Constituencies in Kenya. *Research Journal of Finance and Accounting*. 2013, 4(9).

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Add: 73 Upper Paya Lebar Road #07-02B, Centro Bianco, Singapore 534818

Tel: +65 91384018

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