



Pentahelix Model in the Prevention of Environmental Accounting Fraud in the 3T Region

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ABSTRACT

Purpose: This research aims to explore strategies to prevent environmental accounting fraud in the digital era by using the Pentahelix model to support the green economy in the 3T (Frontier, Outermost, Disadvantaged) regions.

Design/methodology/approach: This study uses a qualitative descriptive method with data collection techniques through in-depth interviews, observations, and document analysis. The research informants consisted of stakeholders of the Pentahelix model, including governments, academics, entrepreneurs, communities, and the media.

Findings: This study shows that digital technologies such as big data, IoT, and blockchain can enhance transparency and accountability in environmental accounting within the 3T regions. However, poor waste management, lack of oversight, and a profit-focused mindset remain major obstacles. Collaboration through the Pentahelix model engaging government, academia, businesses, communities, and the media—is essential to prevent environmental accounting fraud.

Research limitations/implications: The results of the study show that digital technologies such as big data, the Internet of Things (IoT), and blockchain can increase transparency and accountability in environmental accounting. However, the main challenges include unstructured waste management, lack of oversight due to limited funds, and the greed of business elites who are more concerned with economic profits than environmental sustainability. Collaboration between stakeholders through the Pentahelix model, training, education, and external supervision, and the role of the media in raising public awareness are key to preventing environmental accounting fraud. This research is limited to the 3T region with its unique characteristics, so the results may not be fully generalizable to other regions. In addition, limited access to digital data and logistical constraints in the region are also challenges in this research.

Originality/value: This research provides new insights into the importance of a holistic and inclusive approach through the Pentahelix model in creating a transparent and accurate environmental accounting system in the digital era, especially in the 3T region. This is expected to support sustainable green economic development.

Keywords: Environmental Accounting, Fraud Prevention, Pentahelix Model, Green Economy

I. Introduction

Considering the constant pressure of change rate in the digital era, technological innovations have been the major force for change in different sectors, one

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of which is the sphere of environmental accounting management and reporting. The possible and anticipated gains from the application of information technology in ecological accounting are large (Vongurai, 2024). Technologies such as big data, the Internet of Things (IoT), and blockchain can be used as tools to extract, store, and analyze environmental data in real time, enabling timely and accurate decision-making (Yustina et al., 2024). For instance, IoT sensors can be utilized for real-time monitoring of greenhouse gas emissions, while blockchain can be applied to ensure the integrity and transparency of environmental accounting data (Ageeva et al., 2021).

However, on the other hand, the digital era also brings new threats, particularly related to environmental fraud in accounting. Such fraudulent actions are likely to conceal the reality of environmental damage and hinder conservation efforts. One clear example of this threat is the Volkswagen diesel emission scandal, a classic case where technology was used to undermine public trust through manipulated emission tests (Rosita Eberechukwu Daraojimba et al., 2023). North Gorontalo Regency is rich in some of the most stunning scenery Vilas has and North Gorontalo's most beautiful beaches display sparkling white sand along an unspoiled tropical coconut coastline lined with both palm trees visibly perfect where one could experience bird songs and sea breezes without hearing any human noise Despite its wealth of natural resources, North Gorontalo Regency is suffering from vulnerability caused by the irresponsible exploitation of those resources. These challenges include deforestation, pollution, and loss of biodiversity All of these are compounded by corruption in environmental accounts reporting. In North Gorontalo Regency, deforestation continues to be a significant problem. Data provided by the Central Bureau of Statistics shows that the area of forest last three years after 1999 was substantially larger than 2020--this may be partly due to their untreated timbers and mean many buildings just lie around like that heap in the yard for which we cannot find a truck all year long anymore In 2020 the forest area of North Gorontalo Regency was about 512 000 hectares yet every year 1-2 percent

of this region is being destroyed by illegal logging and land conversion." Moreover, information from North Gorontalo Regency's Environmental Agency shows readers that in its main rivers and water courses pollution has risen over five years. This has had a major impact on the quality of life for people living all around those rivers. Such environmental destruction often results in both the threat to native ecosystems and wildlife on its land and economic and social consequences for local people. In addition to this, for agriculture and fishing two occupations that many residents are engaged in heavily the inhabitants of a fishing village only a river estuary poorly in places may have found their fishing catches dropped or produce dwindled (Jaruwanakul, 2024). Once again, this situation is made far worse by the lack of environmental accounting practices and technology. People along the river all too often have no chance to enjoy these benefits. Within the framework of Indonesia's national development strategy outlined in the National Medium-Term Development Plan (RPJMN), the 3T (Frontier, Outermost, and Disadvantaged) regions have a significant role in maintaining state sovereignty and have a wealth of large natural resources. However, the region is also faced with serious challenges related to sustainable development, especially due to limited access to technology and infrastructure. Therefore, this research focuses on the use of digital technology and the application of the Pentahelix model which involves synergy between the government, academia, the business world, the community, and the media to strengthen accountability and transparency in environmental reporting, to support the achievement of green and sustainable economic development in the region. Research focused on preventing environmental accounting fraud in certain regions is still very limited, especially those considering the Pentahelix model in the development of a green economy in 3T areas. Most previous studies have primarily concentrated on the application of environmental accounting in large organizations or already developed areas. One of them is research by Solovida and Latan (2017) showing that the implementation of a strong

environmental strategy can improve company performance through the effective use of environmental management accounting. In urban areas, stricter environmental regulations as well as wider access to technologies such as big data and blockchain facilitate better oversight in environmental reporting (Mankgele, 2023). The study also underscores the gap between more developed urban areas and 3T areas, where limited technology and resources hinder the implementation of transparent and effective environmental accounting. Consequently, there is a lack of research exploring how digital technology can be effectively utilized to prevent environmental accounting fraud in underdeveloped regions. North Gorontalo Regency, rich in natural resources, is also highly vulnerable to unsustainable exploitation, deforestation, pollution, and loss of biodiversity. All of these issues are further exacerbated by fraud in environmental reporting. These discrepancies not only harm the ecosystem and biodiversity but also necessitate the detection and planning of effective strategies for prevention.

The innovation proposed in this research occurs in several aspects. First, this study analyzes the development of the Pentahelix model based on collaboration between the government, universities, businesses, communities, and the media. This model is expected to enhance synergy among various stakeholders in preventing environmental accounting fraud and supporting sustainable green economic development (Ez-Zaidi & Ghandari, 2023). Second, positioning this research in North Gorontalo Regency, a 3T area, focuses on regions often overlooked in previous studies. This is crucial for creating more inclusive and locally relevant solutions. Third, this

research emphasizes how digital technologies like big data, IoT, and blockchain can be applied in environmental accounting to enhance transparency and accountability and reduce the risk of fraud (Ageeva et al., 2021). Finally, it highlights that a holistic approach, which integrates perspectives from various disciplines, is expected to create comprehensive and innovative strategies for preventing environmental accounting fraud and supporting green economic development in 3T regions.

II. Method

The method used in this study is a qualitative description, as done by Baxter et al. (2019) and Hallberg (2017). The use of this technique forms the basis of any procedure involving information gathering. Qualitative descriptive research allows researchers to access highly detailed information through interviews, observation, and document analysis, enabling the analysis of complex phenomena in their real context.

Data was collected through unstructured interviews, direct observation of business activities and environmental conditions, and related documentation. The data collection process included in-depth interviews with informants representing the Pentahelix model, including government, academia, business, community, and media. Direct observation of business activities and environmental conditions was also conducted to gain a clearer understanding of environmental accounting practices.

Table 1. List of informants

Informant's Name	Activity
Andre	Gorontalo Provincial Environment Agency
Halima	UMKM
Dewi	Environmental NGO (JAPESDA)
Fitri	Academician of the Head of the Academic Study Program
Ardi	Journalist (Online Media)

Table 2. Environmental conditions and damage

Team	Coding	Quotes
Environmental Conditions and Damage	Unstructured Waste Management	• The biggest environmental damage activity is unstructured waste management plus small landfill discharges
	Lack of Supervision	• There have been cases of environmental damage in several business places because we do not carry out active supervision because we are hampered by budgeting
	The Greed of the Business Elite	• The current environmental conditions of Gorontalo are no longer conducive due to the greed of the business elite, but we also cannot deny that there are human resources who need a life from these business activities
	Industrial Activities and MSMEs	• The current environmental condition has been degraded due to the presence of industrial businesses that damage and deforestation and MSME actors who do not manage their waste properly
	Deforestation	• The current environmental conditions are very unconducive due to greed in the form of converting forest land into business and agricultural fields

Source: Informant Interview

Table 1 displays a summary of the research informants. These informants represent a Penta helix model consisting of various sectors. They include the government that focuses on business licensing and environmental regulations, MSME actors, Environmental NGOs (JAPESDA) that prioritize environmental advocacy, the Secretary of the Accounting Study Program, and an online media journalist.

The names of the research informants listed in Table 1 are not real names. The names were disguised at the request of the informant taking into account various reasons. The selection and determination of informants is based on the following considerations: first, Andre is a business environmental supervisor who is in charge of supervising the environmental impact of business activities. Second, Halima is a business actor who is directly involved in environmental management around her business land. Mrs. Dewi is the secretary of the NGO Natural Resource Management.

Advocacy Network (JAPESDA), which aims to ensure the sustainability of ecosystems and livelihoods for people between generations. The other two informants are Mrs. Fitri, an environmental accounting practitioner and secretary of the accounting study

program, and Ardi, an online media journalist.

III. Results and Discussion

A. Environmental Management Accounting

Environmental Management Accounting (*EMA*) is an accounting system used to measure, analyze, and report on the environmental aspects of a company's operational activities (R. Gray, J. Bebbington, 1993). From the results of interviews with informants, several main factors that contribute to poor environmental conditions and environmental damage due to the lack of poor environmental management can be identified, which can be seen in Table 2.

Based on interviews with informants, the researcher found that the environmental conditions in the Gorontalo research area are very concerning. Several key factors contribute to significant environmental damage.

First, unstructured waste management is the main contributor to environmental damage. Andre revealed that poor waste management, coupled with the small capacity of landfills, leads to excessive waste

accumulation. This situation results in soil and water pollution, as well as other negative impacts on local ecosystems. This was stated by Andre in an interview that stated that:

...The biggest environmental damage activity is unstructured waste management plus small landfill discharges

To face these challenges, it is very important to develop Environmental Accounting guidelines in business strategies. Environmental accounting has an important role in business strategy, where it aims to measure and report on the company's environmental performance. By implementing a strong environmental strategy, companies can improve environmental performance through environmental management accounting. As revealed by Solovida and Latan (2017), an effective environmental strategy can improve a company's environmental performance through the application of environmental management accounting. This confirms how important better and more structured waste management is in improving the company's environmental performance. Thus, the company can not only fulfill its social responsibility but also achieve better environmental sustainability.

Second, the lack of active supervision of business activities is also a big problem. Andre stated that budget limitations hinder them from conducting active supervision. As a result, many violations go undetected and are not properly addressed. This shows the importance of adequate budget allocation to ensure effective and sustainable environmental monitoring. Stronger oversight will help prevent environmental damage caused by irresponsible business activities.

"There have been several cases of environmental damage in several businesses because we do not carry out active supervision because we are hampered by budgeting, for example, it occurred at PT. Trijaya Tangguh, our team will go down later, there will be reports from the public and news in the media,..."

Effective environmental monitoring is essential to prevent environmental damage caused by irresponsible business activities. Adequate budget allocation, use

of technology, personnel training, and collaboration with local communities are important steps to improve the effectiveness of environmental monitoring. By doing so, companies can identify and manage the environmental impact of their activities, as well as increase transparency and accountability. Gunarathne et al. (2021) found that effective environmental management strategies and environmental management accounting can improve the environmental and economic performance of organizations.

Third, the greed of the business elite is also a significant factor in environmental degradation. Dewi revealed that environmental conditions in Gorontalo are no longer conducive due to the greed of the business elite. They often ignore environmental impacts for the sake of economic gain. However, many people depend on these economic activities for their livelihoods. Therefore, it is necessary to have a balanced approach that combines economic growth with environmental protection. Stricter regulations are needed to control the environmental impact of business activities, ensuring that economic interests do not damage environmental sustainability. With a slightly heartfelt tone and facial expression, the goddess said:

...The current environmental conditions of Gorontalo are no longer conducive due to the greed of the business elite, but we also cannot deny that there are human resources who need life from these business activities.

A balanced approach between economic growth and environmental protection is urgently needed. Businesses should be encouraged to adopt environmentally friendly practices without sacrificing economic growth. Strict regulations and effective law enforcement are essential to control the environmental impact of business activities. Governments must ensure that companies adhere to strict environmental standards and take necessary steps to reduce their negative impact on the environment. Ekundayo and Odhigu (2020) emphasized the importance of

environmental accounting to support corporate sustainability, especially in the context of a growing economy. While Gunarathne et al. (2021) emphasized that an effective environmental management strategy can improve a company's environmental performance through the implementation of strict regulations.

Fourth, unsustainable industrial activities and deforestation also contribute greatly to environmental degradation. Fitri revealed that environmental conditions are getting worse due to the presence of industrial businesses that destroy and clear forests, as well as MSMEs that do not maintain their waste management. Industries and MSMEs need to implement more sustainable and environmentally friendly business practices. Stricter regulations and the application of environmentally friendly technologies are urgently needed. In addition, awareness and support for MSMEs in implementing good waste management practices must be increased. With a serious face and a little annoyed, Fitrianti revealed:

...The current environmental condition has been degraded due to the presence of industrial businesses that damage and deforestation and MSME actors who do not maintain their waste management

Unsustainable industrial activities and deforestation are the main factors that worsen environmental conditions in Gorontalo. To overcome this problem, industry, and MSMEs need to implement sustainable and environmentally friendly business practices, as stated by Ariani and Zulhawati (2023) Industry and MSMEs need to implement sustainable business practices to reduce negative impacts on the environment. This includes the efficient use of resources, good waste management, and the protection of forest areas. Stricter regulations, the application of environmentally friendly technology, and increased awareness and support for MSMEs in managing their waste are important steps that must be taken (Sekerez, 2017). Thus, environmental degradation can be reduced and environmental sustainability can be maintained.

Finally, deforestation to be used as a business field without considering the environmental impact leads to the loss of natural habitat and a decrease in biodiversity. Ardi stated that the greed of businesspeople who turn forest land into business fields has worsened environmental conditions. Deforestation also contributes to local and global climate change. Therefore, stricter policies are needed to protect forests and regulate deforestation. Effective law enforcement is also important to ensure compliance with environmental regulations. Ardi while approaching and whispering a little said:

The current environmental conditions are very uncondusive due to greed in the form of converting forest land into business fields such as illegal mining, the activities of mineral and mineral companies. People don't know if it's a landslide (they don't care if it's going to be a landslide or not)...

Deforestation carried out for business purposes without considering the environmental impact has caused significant environmental damage in Gorontalo. This deforestation not only deprives natural habitats and reduces biodiversity, but also contributes to local and global climate change. Stricter policies are needed to protect forests from unsustainable deforestation. Governments must enact strong regulations to prohibit or limit the conversion of forests into commercial land without adequate environmental impact analysis. As stated by Sekerez (2017) strict policies and good environmental accounting are essential for the development of strategic initiatives in environmental protection and supporting the sustainable development of companies.

B. The Role of Pentahelix in Environmental Monitoring and Mitigation

Environmental monitoring and mitigation are important steps that must be taken to ensure that business and industrial activities do not harm the

Table 3. Environmental conditions and damage

Theme	Coding	Quotes
Environmental Monitoring and Mitigation	• Inadequate Environmental Supervision	• Environmental Mitigation is already in the company's business plan, but the agency does not carry out active supervision unless there is fraud and public reports
	• Lack of Post-Issuance Supervision of SPPL	• Managing permits is currently very easy through OSS, which produces NIB and SPPL. However, there is no direct supervision from the agency regarding the SPPL issue.
	• Difficulties in Supervision by Community Organizations	• difficulties in conducting direct supervision due to limited access provided by the government and companies.

Source: Informant Interview

environment. Environmental stewardship involves continuous monitoring of business activities to detect and address environmental violations. Environmental mitigation, on the other hand, involves implementing measures designed to reduce or eliminate negative impacts on the environment. This is seen in Table 3.

First, environmental supervision and mitigation in the Gorontalo area face various significant challenges. One of the main problems is inadequate environmental supervision. Andre revealed that although entrepreneurs have promised to mitigate the environment in the feasibility study of building a business for the first time, active supervision is not carried out unless there is a report from the community. Budget constraints are often the main obstacle in the implementation of this active supervision. As a result, many environmental violations go undetected and are not properly followed up. Andre said with a smile:

“Entrepreneurs have promised to mitigate the environment in the first feasibility study of building a business. However, DLH does not conduct active supervision unless there is a report from the community, and budget constraints hinder active supervision”

Although employers have expressed their commitment to environmental mitigation, the lack of active oversight from relevant agencies shows weaknesses in the implementation of the pledge. The reliance on community reports shows that this reactive

surveillance system is insufficient to prevent violations in the first place. Budget constraints underscore the need for greater and more effective allocation of funds for proactive and sustainable environmental stewardship. To overcome this problem, the implementation of modern technologies, such as environmental sensors, drones, and geographic information systems (GIS) is needed that improve the efficiency and effectiveness of environmental monitoring. This technology allows for early detection of violations and more effective monitoring. As stated by Croce and Tondini (2022), the importance of using low-cost technology for urban microclimate monitoring, which can help define responsive and adaptive mitigation strategies.

Second, the ease of the permit management process through OSS does make it easier for business actors, but the lack of supervision after the issuance of the Environmental Management and Monitoring Capability Statement (SPPL) creates a loophole for environmental violations. Without adequate supervision, many businesses may not comply with environmental regulations. This shows that an efficient licensing system must be followed by a strict supervision mechanism. "The ease of obtaining permits must be in line with strict supervision to ensure compliance with environmental regulations. The lack of supervision after the issuance of SPPL is also a big challenge. Halima revealed that taking care of permits is currently very easy through OSS, which produces NIB and SPPL. However, there is no direct supervision from

the agency regarding the SPPL issue. It is stated emphatically that:

Taking care of permits is currently very easy through OSS, which produces NIB and SPPL. However, there is no direct supervision from the agency related to the SPPL (Halima) issue.

The ease of the permit process through OSS must be followed by a strict monitoring mechanism to ensure compliance with environmental regulations. The lack of supervision after the issuance of the SPPL creates a loophole for environmental violations. Therefore, it is necessary to strengthen the monitoring mechanism and implement a community-based monitoring system to ensure effective environmental protection. Sofia et al. (2020) emphasized that ease of administration through OSS can improve business efficiency, but it must be balanced with strict environmental supervision to ensure regulatory compliance. The government needs to strengthen the supervision mechanism by providing adequate resources to conduct inspections and post-issuance monitoring. This includes the use of modern technology to detect violations more efficiently.

Third, there is no provision of access and information to community organizations to carry out independent supervision of business activities such as JAPESDA organizations which face difficulties in conducting direct supervision. They revealed that limited access provided by governments and companies is often a major obstacle. Although JAPESDA focuses on raising public awareness of the importance of preserving the environment, without adequate support and access, their efforts are often ineffective. Closer cooperation between governments, community organizations, and companies is needed to ensure more effective environmental monitoring. This was conveyed by the goddess while taking a long breath:

...We face difficulties in conducting direct supervision due to limited access provided by the government and companies. So we

changed this scheme to focus on increasing public awareness about the importance of preserving the environment...

JAPESDA points to limited access to direct supervision, which is often caused by a lack of support from the government and companies. Although their efforts in raising public awareness are critical, without adequate access, the effectiveness of their surveillance remains limited. This highlights the need for closer cooperation between governments, community organizations, and the private sector to improve environmental stewardship. "Raising public awareness is important, but it must be balanced with adequate access to direct supervision.". Danielsen et al. (2022) highlighted that community-based environmental monitoring (CBM) can be effective if there is adequate access to information and support from governments and other organizations, as is the case with EIST et al. (2020) emphasizes the importance of collaboration between the government, companies, and the community in effective environmental management. Based on this problem, the Government and companies must provide adequate access to civil society organizations to carry out independent supervision. This includes access to environmental data, business locations, and other relevant information. Just like what Mercer et al. said. (2023) that adequate access to information is essential for the effectiveness of environmental monitoring and mitigation.

C. Environmental Accounting Fraud Prevention Strategy

Environmental accounting fraud prevention strategies involve the implementation of transparent accounting systems, external supervision and audits, training and education for employees, the implementation of information technology, and strong policies and regulations. Collaboration between governments, companies, community organizations, and the media is essential to ensure the success of this strategy. With concerted efforts, we can create an environmental

Table 4. Strategies and solutions for preventing environmental accounting fraud

Theme	Coding	Quotes
Strategies and Solutions	Implementation of a Transparent Environmental Accounting System	We encourage the use of a transparent environmental accounting system to ensure that all recording and reporting activities are carried out by standards
	External Supervision and Audit	We recommend regular external oversight and audits to ensure compliance with environmental and accounting regulations.
	Training and Education for Employees	We recognize the importance of training and education for employees in understanding and applying the correct environmental accounting.
	The Role of the Media in Environmental Monitoring:	The current environmental conditions are not interesting to cover because the views are very few, so many of us do not cover them, unless the local government directs its focus to the environment, surely we will be busy making a tagline about environmental awareness.

accounting system that is more accurate, transparent, and free from fraud. From the results of interviews with informants, several main factors that contribute to the environmental accounting fraud prevention strategy model can be identified, which is shown in Table 4.

First, the implementation of a transparent environmental accounting system is very important to prevent fraud in environmental reporting. By using a clear and accessible system to all stakeholders, companies can ensure that all environment-related activities are accurately recorded and that there is no data manipulation. This is in line with the expectations of the environmental agency, in this case represented by Ardi who said that :

...We encourage the use of a transparent environmental accounting system to ensure that all recording and reporting activities are carried out by standards..

The implementation of a transparent environmental accounting system is essential to prevent fraud in environmental reporting. Transparency in environmental accounting ensures that all relevant environmental data is available and accessible to stakeholders, including reporting on resource use, emissions, and other environmental impacts. Research by Zheng and Shi (2023) shows that increased transparency in

environmental accounting disclosures can improve corporate social responsibility and support sustainable growth. Additionally, adopting international standards in environmental accounting systems helps ensure that reported data is consistent and comparable to other companies, facilitating independent audits and verifications. Research by Marlina and Syahril (2022) shows that the implementation of good environmental accounting standards can optimize the company's environmental management. On the research side, Caputo et al. (2021) also support the importance of transparency for regulatory compliance and corporate governance. The use of modern technologies such as blockchain and IoT in environmental accounting systems can improve data transparency and accuracy, enabling real-time tracking and independent verification of environmental data, as discovered by Zhang and Zhu (2022). In addition, the role of the media in monitoring and reporting on environmental issues is essential to increase public awareness and corporate accountability, especially if it is supported by local governments directing their focus to environmental issues (Mercer et al., 2023).

Second, adopting an integrated environmental accounting system is not only a matter of compliance with regulations but an important step to ensure that every business decision taken by a company takes into account environmental impacts. With this system,

companies can track and manage the environmental impact of every aspect of their operations, from resource use to emissions and waste, holistically.

We encourage companies to adopt an environmental accounting system that is integrated with their operations to ensure that all environmental aspects are considered in business decision-making, said Andre DLH

Integrating environmental accounting into a company's operations ensures that environmental impacts are considered in every business decision. This allows companies to take proactive steps in managing and reducing negative impacts on the environment. Abbasabadi et al. (2021) showed that transparency in environmental accounting can be achieved through integrated reporting, which includes financial and non-financial aspects to ensure comprehensive and accurate environmental information.

Third, training and education for employees is essential to ensure that all employees understand the importance of environmental accounting and how to implement it correctly. Well-educated employees will be more aware of their responsibilities in maintaining environmental data integrity and complying with regulations. Ongoing education helps employees understand and adopt best practices in environmental accounting, thereby reducing the likelihood of fraud. This was conveyed by Halima who is an MSME Business actor.

We recognize the importance of training and education for employees in understanding and applying the correct environmental accounting.

Training and education provide the knowledge and skills necessary for employees to understand and implement environmental accounting correctly. This includes understanding regulations, reporting procedures, and the importance of transparency in environmental data reporting. The same is true of what Belousov et al. said. (2023) emphasizes the importance of

professional competence in environmental accounting, which can be achieved through continuous training and education. Another argument is reinforced by the statement of Mukwarami and van der Poll (2022) that environmental education can increase employee awareness and understanding of the importance of good environmental accounting practices, as well as improve the company's environmental performance. On the other hand, Popov (2020) stated that the implementation of environmental accounting through training can improve the company's economic and environmental performance. Training and education for employees are essential to ensure that all members of the organization understand the importance of environmental accounting and how to implement it correctly. Well-educated employees will be more aware of their responsibilities in maintaining environmental data integrity and complying with regulations. With ongoing training, companies can adopt best practices in environmental accounting, improve environmental performance, and reduce the risk of fraud.

Fourth, the implementation of information technology, such as information technology-based environmental management systems, can help in monitoring and reporting environmental data more efficiently and accurately. This technology allows for real-time data collection and early detection of anomalies that may indicate fraud. Fitri, who is an environmental accounting lecturer, explained that:

The use of information technology in monitoring and reporting environmental data can increase the accuracy and speed of detecting fraud.

Information technology allows companies to monitor environmental data in real-time. This allows for early detection of anomalies that may indicate cheating, as well as ensuring that the data collected is accurate and reliable. This is in line with what was stated by Hassanin & Vyas (2023) that information technology plays an important role in environmental protection through real-time monitoring

and big data analysis, which helps in making better decisions regarding environmental impacts. In addition to this, technologies such as IoT also allow the collection of environmental data in real-time through sensors embedded in each business location. This data is then analyzed to provide deeper insights into environmental conditions and potential fraud. Computer-based environmental management systems can be integrated with ERP and IoT technologies to create a comprehensive monitoring platform. This allows companies to manage environmental data along with other operational data. I. Kovalev et al. (2021) show that the integration of software and hardware technology in environmental monitoring systems can improve data security and system resilience.

Fifth, the role of the media in environmental supervision is very important to increase public awareness and encourage corporate accountability. While environmental issues are often less attractive to the media, support from local governments can direct media attention to crucial environmental issues. With extensive media coverage, information about environmental conditions can be disseminated more effectively, prompting further action from the community and authorities. Judging from the results of the interview with Ardi, who is one of the online media journalists, the government must focus on environmental issues so that the media will also flock to cover environmental issues.

The current environmental conditions are not interesting to cover because the views are very few, so many of us do not cover, unless the local government directs its focus to the environment, surely we will be busy making a tagline about environmental awareness. Said Ardi..

Consistent media coverage of environmental issues can increase public awareness and encourage collective action for environmental protection. The media has the power to influence public opinion and encourage behavior change. Chang et al. (2020) show

that media coverage of environmental pollution can increase corporate investment in green practices and social responsibility. In addition, the media can serve as an effective external watchdog, forcing companies to improve their environmental performance. When the media reports on environmental issues, companies tend to be more responsible in managing their environmental impact. This is supported by the statement of Guo and Lu (2020) that media attention can significantly affect a company's environmental performance, especially in areas that are the focus of government attention in terms of low environmental protection. Finally, social media can be used as a platform for crowdsourcing environmental data and increasing public participation in environmental surveillance. The use of social media allows environmental information to spread quickly and widely. Lawu et al. (2021) examined the use of crowdsourced data from social media for environmental planning and monitoring, which shows great potential in environmental management through public engagement.

This study found significant differences between 3T areas and urban areas in the application of environmental accounting, where urban areas have wider access to advanced technologies such as *big data*, *blockchain*, and *IoT*. This technology allows for stricter oversight and greater transparency in environmental accounting reporting. Stricter environmental regulations in urban areas also add to the effectiveness of the implementation of environmental accounting, encouraging companies to adhere to high standards in environmental management (Mazhenova et al., 2016). On the other hand, the 3T region faces structural obstacles that increase the risk of environmental accounting fraud. Limited infrastructure, limited access to technology, and a lack of effective oversight make transparent environmental accounting practices much more difficult to implement. These factors create a huge gap that requires a collaboration-based solution. The Pentahelix model, which involves the government, academia, the business world, the community, and the media, is proposed as a mechanism to overcome

these limitations. This model is not only relevant because it strengthens coordination between stakeholders, but also because it specifically addresses the unique challenges faced by the 3T region, such as the lack of technological support and low surveillance capacity.

IV. Conclusion

Based on the description above, this study reveals that information technology has an important role in improving environmental accounting in the 3T region. However, challenges such as unstructured waste management, lack of oversight due to limited funds, and the greed of business elites who are more concerned with economic profits than environmental sustainability, exacerbate the situation. Unsustainable industrial and MSME activities and deforestation for business purposes without taking into account environmental impacts also cause damage to natural habitats and a significant decline in biodiversity for local ecosystems. To meet these challenges, Pentahelix's approach involving collaboration between government, academia, business, community, and media is considered the most effective solution. Through this synergy, we can encourage the application of digital technologies such as big data, IoT, and blockchain to increase transparency and accountability in environmental management. In addition, the importance of training and education for employees, external supervision and auditing, and the role of the media in increasing public awareness are the main keys in the environmental accounting fraud prevention strategy. With this holistic and inclusive approach, we hope to create a more honest, transparent, and sustainable environmental accounting system, to support the development of a sustainable and green economy in the 3T region.

References

- Ageeva, O., Karp, M., & Sidorov, A. (2021). *The Application of Digital Technologies in Financial Reporting and Auditing* (pp. 1526-1534). Springer. doi:10.1007/978-3-030-59126-7_167
- Belousov, A., Sheluhina, E., Blizno, L., Lescheva, M. G., & Bogataya, I. N. (2023). *Environmental accounting and analysis*. INFRA-M Academic Publishing LLC. doi: 10.12737/1019902
- Caputo, F., Pizzi, S., Ligorio, L., & Leopizzi, R. (2021). Enhancing environmental information transparency through corporate social responsibility reporting regulation. *Business Strategy and the Environment*, 30(8), 3470-3484. doi:10.1002/bse.2814
- Chang, Y., He, Y., Jin, X., Li, T., & Shih, C. M. (2020). Media Coverage of Environmental Pollution and the Investment of Polluting Companies*. *Asia-Pacific Journal of Financial Studies*, 49(5), 750-771. doi:10.1111/ajfs.12315
- Croce, S., & Tondini, S. (2022). Fixed and Mobile Low-Cost Sensing Approaches for Microclimate Monitoring in Urban Areas: A Preliminary Study in the City of Bolzano (Italy). *Smart Cities*, 5(1), 54-70. doi:10.3390/smartcities5010004
- Danielsen, F., Eicken, H., Funder, M., Johnson, N., Lee, O., Theilade, I., ... Burgess, N. D. (2022). Community Monitoring of Natural Resource Systems and the Environment. *Annual Review of Environment and Resources*, 47(1), 637-670. doi:10.1146/annurev-environ-012220-022325
- Ekundayo, G., & Odhigu, F. (2020). Environmental Accounting and Corporate Sustainability: A Research Synthesis. *International Journal of Business and Management*, 16(1), 1. doi:10.5539/ijbm.v16n1p1
- Ez-Zaidi, A., & Ghandari, Y. (2023). Audit profession and innovation: Emerging practices in the era of digital transformation and their relationship to the environment. *E3S Web of Conferences*, 412, 01010. doi:10.1051/e3sconf/202341201010
- Feist, A., Plummer, R., & Baird, J. (2020). The Inner-Workings of Collaboration in Environmental Management and Governance: A Systematic Mapping Review. *Environmental Management*, 66(5), 801-815. doi:10.1007/s00267-020-01337-x
- Gunaratne, A. D. N., Lee, K., & Hitigala Kaluarachchilage, P. K. (2021). Institutional pressures, environmental management strategy, and organizational performance: The role of environmental management accounting. *Business Strategy and the Environment*, 30(2), 825-839. doi:10.1002/bse.2656
- Guo, Z., & Lu, C. (2020). Corporate Environmental Performance in China: The Moderating Effects of the Media versus the Approach of Local Governments. *International Journal of Environmental Research and Public Health*, 18(1), 150. doi:10.3390/ijerph18010150
- Hatem Hassanin, & Jitendra Vyas. (2023). Information Technology And Ecology Environmental Protection. *EPRA International Journal of Multidisciplinary Research (IJMR)*, 9(12), 147-151. doi:10.36713/epra15141

- Jaruwanakul, T. (2024). The Influence of AI-CRM Adoption and Big Data Analytical Capability on Firm Performance of Large Enterprises in Thailand. *Global Business and Finance Review*, 29(2), 112-126. doi:10.17549/gbfr.2024.29.2.112
- Kovalev, I. V., Testoyedov, N. A., Kovalev, D. I., Losev, V. V., Tynchenko, Y. A., Golovenkin, E. N., & Maksimov, I. A. (2021). Analysis of software and hardware technologies of information-measuring systems for environmental monitoring. *Journal of Physics: Conference Series*, 1889(3), 032039. doi:10.1088/1742-6596/1889/3/032039
- Lawu, B. L., Lim, F., Susilo, A., & Surantha, N. (2021). Social media data crowdsourcing as a new stream for environmental planning & monitoring: A review. *IOP Conference Series: Earth and Environmental Science*, 729(1), 012013. doi:10.1088/1755-1315/729/1/012013
- Mankgele, K. P. (2023). Green Entrepreneurial Self-efficacy and Environmental Performance of SMEs: Mediating and Moderating Role of Green Innovation and Green Purchase Behaviour. *Global Business and Finance Review*, 28(6), 48-58. doi:10.17549/gbfr.2023.28.6.48
- Marlina, D., & Syahril. (2022). Environmental Accounting For The Management of Corporate Social Responsibility Pt.Garam Klianget. *International Journal of Global Accounting, Management, Education, and Entrepreneurship*, 2(2), 89-96. doi:10.48024/ijgame2.v2i2.52
- Mazhenova, S., Choi, J. G., & Chung, J. (2016). International tourists' awareness and attitude about environmental responsibility and sustainable practices. *Global Business and Finance Review*, 21(2), 132-146. doi:10.17549/gbfr.2016.21.2.132
- Meiliyah, A., & Zulhawati. (2023). Application of environmental management accounting and strategy to company innovation with research and development effort and company size as control variables. *International Journal of Research in Business and Social Science* (2147- 4478), 12(8), 289-298. doi:10.20525/ijrbs.v12i8.3037
- Mercer, L., Whalen, D., Pokiak, D.-L., Lim, M., & Mann, P. J. (2023). Ensuring continuity and impact in Arctic monitoring: A solution-orientated model for community-based environmental research. *Environmental Research: Ecology*, 2(4), 045001. doi:10.1088/2752-664X/ad0241
- Mukwarami, S., & M van der Poll, H. (2022). Environmental management accounting framework for small businesses. A case of blacked-owned businesses in a developing economy. *Global Conference on Business and Social Sciences Proceeding*, 14(2), 1-1. doi:10.35609/gcbssproceeding.2022.2(84)
- Popov, A. (2020). Implementing Environmental Accounting as a Factor of Organization's Economic Security. In *Proceedings of the Ecological-Socio-Economic Systems: Models of Competition and Cooperation (ESES 2019)*. Atlantis Press. doi:10.2991/assehr.k.200113.113
- R. Gray, J. Bebbington, M. H. (1993). Accounting for the Environment. In *Encyclopedia of Corporate Social Responsibility* (pp. 22-22). Springer Berlin Heidelberg. doi:10.1007/978-3-642-28036-8_100017
- Rosita, E. D., Oluwatoyin, A. F., Funmilola, O. O., Noluthando, M., & Timothy, T. O. (2023). Forensic accounting in the digital age: a u.s. perspective: scrutinizing methods and challenges in digital financial fraud prevention. *Finance & Accounting Research Journal*, 5(11), 342-360. doi:10.51594/farj.v5i11.614
- Sekeze, V. (2017). Environmental Accounting as a Cornerstone of Corporate Sustainability Reporting. *International Journal of Management Science and Business Administration*, 4(1), 7-14. doi:10.18775/ijmsba.1849-5664-5419.2014.41.1001
- Solovida, G. T., & Latan, H. (2017). Linking environmental strategy to environmental performance. *Sustainability Accounting, Management and Policy Journal*, 8(5), 595-619. doi:10.1108/SAMPJ-08-2016-0046
- Vongurai, R. (2024). Investigating Industry 4.0, Blockchain Adoption, and Sustainability on Thai Finance's Operational Excellence. *Global Business and Finance Review*, 29(5), 88-102. doi:10.17549/gbfr.2024.29.5.88
- Yustina, A. I., Dewi, C. N., Mahmudah, H., & Andreanantenaina, H. (2024). Corporate Governance Mechanism for Carbon Emission Disclosure: Evidence from State-Owned Enterprises in Indonesia. *Global Business and Finance Review*, 29(4), 28-42. doi:10.17549/gbfr.2024.29.4.28
- Zheng, Q., & Shi, D. (2023). Research on the Disclosure of Environmental Accounting Information in Listed Steel Companies. *Frontiers in Business, Economics and Management*, 11(2), 9-13. doi:10.54097/fbem.v11i2.12155