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The Role of Functional Imperatives in Stimulating Carbon Management Accounting By Mediating Management Accounting in Waste Management

Budi Prajogo[1], Etty Murwaningsari[2], Sekar Mayangsari[3]

[1 2 3]Economics Doctoral Study Program, Accounting Science Concentration,

Faculty of Economics and Businesss, Universitas Trisakti

budi222160403@std.trisakti.ac.id[1]

etty.murwaningsari@trisakti.ac.id[2]

sekar_mayangsari@trisakti.ac.id[3]

Abstract.
The aims of this research to examine and analyze the effect of Functional Imperatives (FI) on "Environmental Management Accounting" (EMA) and "Carbon Management Accounting" (CMA), as well as to analyze the indirect effect of FI on CMA mediated by EMA. This quantitative study performed hypothesis tests on the three variables, namely CMA (5 dimensions and 16 measurement indicators), EMA (3 dimensions, 10 subdimensions, and 43 indicators), and FI (3 dimensions with 15 indicators), where all measurements used a Likert scale of 1 to 7. Furthermore, the samples were collected using the purposive sampling technique with certain criteria, including stakeholders, namely the waste bank manager and the authorized government. The samples were 445 respondents with a requirement of at least 5 times the number of indicators (370 respondents). The analytical method used was SEM-PLS. The results showed the FI had a positive effect on EMA and CMA. Also, EMA is proven to have a positive effect on CMA and mediates the effect of FI on CMA.

Keywords. Functional Imperatives, Environmental Management Accounting, Carbon. Management Accounting

I. INTRODUCTION

Carbon emissions have a critical influence on human life and are recognized as a primary contributor to climate change. The excessive release of gases into the atmosphere leads to global warming, also known as the greenhouse effect, This is causing the temperarute rise on earth and execerbating climate change. Carbon widely acknowledged as a major factor in the escalation of climate change, stemming from the proliferation of industrial units and environmental degradation. Studies have been conducted on the performance, emissions, disclosure, and tax of carbon [1], [2] [3] [4] [5] to understand its impact on the environment. Carbon Tax is a tax imposed on carbon emissions that have a detrimental effect on the environment. The topic has become a subject of interest in Indonesia after the recent Tax Harmonization Act, which is regulated by Law 7/2021 concerning the Harmonization of Tax Regulations (HPP). The increasing of population and energy use in urban areas contribute to global warming by leading at a higher atmospheric pollution level, which harms people's health, causes thick smoke, damages plants, exacerbates changes weather, poses a threat to community sustainability [6] Waste also leads to the release of carbon emissions that contribute to global warming

According to data from The Economist Intelligence Unit in 2017, Indonesia is the second-largest waste contributor globally and the third-largest plastic waste producer, with 67.8 million tons of plastic waste produced, or 185,753 tons per day from 270 million people (page indonesia.go.id, 2020). The country also contributes to plastic waste in the sea with 56.3 million kilograms and has the most polluted river in the world, the Citarum River. Waste burning contributes approximately 43% of total greenhouse gas emissions, which is a significant portion of CO2 emissions. These carbon emissions have significant impacts, such as erratic climate change, leading to floods, hunger, and economic instability, as well as increasing air temperatures and causing global warming. This highlights the substantial risk posed by carbon emissions from waste generated in Indonesia, making it crucial to consider their impact.

The growth of environmental awareness, especially waste management, makes stakeholders realize that industrialization, economic growth, and development go beyond the natural biological limits the planet can bear [7]. The need

for environmental accounting namely, user needs, also arises from external companies. Financial report users need social and environmental information for investment decisions. Some opinions state that shareholders are more conservative and only care about the rate of return on investment. However, according to a survey conducted by Marc Epstein on shareholders, companies are expected to use their resources to keep the environment clean, stop environmental pollution, and make safe products [8]

In the context of this study, CMA is more specifically related to EMA. A part of accounting science, EMA helps managers' efforts to achieve improved financial and environmental performance. It systematically integrates the environmental aspects of a company into management accounting and decision-making processes. Furthermore, it helps business people/managers to collect, analyze or link environmental aspects with monetary and physical information. This need has laid the foundation for the emergence of EMA. EMA can eventually be developed to minimize the impact of industrial developments, one of which is the problem of EMA in recent years has provided global warming. Although, it is an inclusive accounting field, it also represents a broader term that is concerned with providing relevant informations, as well as internal and external stakeholders

Referring to [9]–[11] on waste management in local governments, an investigation was carried out on waste management in Indonesia, which is managed by the central government and regions (regencies/cities) under the authority of the public works department as well as the public housing and residential area services. Presidential Regulation Number 97 of 2017 regulates the national strategic policy (Jaktranas) regarding the management of household and household-like waste. The guidelines from this regulation are used as a reference by provincial and regency/city regional governments in establishing regional policies or strategies (Jakstrada). Jakstranas and Jakstrada are national and regional waste management master plans, where the achievements are measured in stages until 2025. An important paradigm in the Jakstranas Presidential Decree is the concept of reducing waste at the source, namely 30% by 2025. To achieve this, the government needs to involve community participation in managing waste through changes in behavior and culture.

Waste management in Indonesia is mostly a centralized pattern, with an open dumping system at the Final Disposal Site (FDS). There are at least three known forms of municipal waste management, namely centralization, decentralization, and centralization-decentralization. However, a good waste management pattern is neither centralized nor decentralized, but the ideal now is centralized-decentralized (ce-decentralized). In this pattern, the community with government guidance forms an Organic Waste Management Installation (OWMI) in every dominant waste source (in the initial stage). Subsequently, the government forms a Waste Recycling Industry, such as the Municipal Waste Management Installation (MWMI) to support and assist the marketing of OWMI which had been established by a Joint Business Group (JBG) in the community. This management method is called the communal pattern or “self-cleaning concept” in dealing with solid waste problems in Indonesia. This means that waste management is not necessarily the responsibility of the government (with an open dumping system) but involves other parties for communal waste managemen

Qian et al. (2011) stated that in EMA, there is an imperative effect on behavior. The effect is Institutional Imperatives and Functional Imperatives (FI) in local government. Institutional Imperatives are carried out by local governments regarding regulations, community expectations, and cognitive pressures. Meanwhile, FI relates to environmental uncertainty, operational complexity, and proactive strategies. This study also refers [9]where the assessment and understanding of EMA in local governments are still not widely examine [10]found that FI is higher than Institutional ones. Therefore this study aims to analyze the effect of FI directly on CMA and indirectly through the mediation of EMA.

II. LITERATURE REVIEW

1. Carbon Management Accounting (CMA)

CMA is one part of sustainability accounting that is used to deliver company information to company managers in the form of short-term agreement and long-term decisions on the problem of carbon emission issues in the world [12]. CMA is the recognition, non-monetary and monetary evaluation, as well as the monitoring of greenhouse gas emissions at all levels of the value chain and their impacts on ecosystem carbon cycle [13], [14]. This technique identifies three main types of CMA used for different purposes namely, organizational, product, and project CMA.

CMA incorporates carbon-related aspects into a company's financial statements. Currently, there is one carbon measurement standard recognized by UNFCCC, namely the National Carbon Accounting Standards (NCAS) which is a national standard owned by Australia. Furthermore, there are several underlying theories in CMA, namely CMA is organizations account for and report on their greenhouse gas emissions [15] Therefore, it can be interpreted as a process of measuring and reporting related to issuers (carbon) produced by a company. [16]explained Exit Price Accounting is a combination of concepts from [17] [18]which measures assets by the realized selling value at the selling price that applies in general. It is one of the measurement methods disclosed by [19] as a system that uses specific market selling prices to measure a company's financia1 position and performance. This method is selected because PSAK 57 states that provisions or contingent assets should be estimated reliably, hence, the latest market price of carbon is used in making the estimate.

2. Environmental Management Accounting (EMA)

EMA can be interpreted in two different approaces. In the first approach, it is considered to be represented by internal EMA using monetary measures. The second is that it with both monetary and non-monetary approaches to internal accounting reflecting a more comprehensive definition [20]. EMA is a recent innovations in management accounting that represent this development. Sustainable development is the more becoming part of the goals of many organizations, lead to strong adoption of environmental management and the use of EMA sysstems. Furthermore, this system is a crucial part of sustainability accounting [21]. In previous studies defined EMA as techniques that generate, analyze, and use financial or non-financial information to improve the environmental as well as the economic performance of companies, and contribute to a sustainable businees (Bennett et al., 2003; Degan, 2003).

The aim of EMA is too provide physical information about the use of materials and energy as well as monetary information concerning costs, revenues, and savings related to the environment. The physical aspects include produc t life cyc le asses ment, as well as impr ovement and inventor y analyses. According to IFAC (2005), EMA is an environmental management as well as organizational economic performance through the development and implementation of accounting systems or practices that suit the needs of the company. The results of the IFAC report (2005) showed the organizations that use EMA tend to carry out more extensive studies as well as design activities in producing environmentaly friendly products and developing techniques that are less harmful to the environment.

3. Functional Imperative (FI)

FI are actions taken by a company to maintain or achieve its performance goals. This is carried out by achieving efficiency in it immediate technical/operational environment, for example, strategic choice, technology, scale, and resources. According to [22] the study of FI associated with EMA is conducted based on three perspectives, namely environmental uncertainty (Organizations are considered adaptive rational systems which have the ability to interact successfully with their dynamic and uncertain environment), strategic proactiveness (Accounting information is needed for support the implementation of organizational strategy at different levels. The more the accounting system is matched to the organization's strategy, the more likely the objective will be achieved. Proactive environmental strategies tend to promote the use of EMA) and operational complexity (An organization is likely too use complex technologies requiring a more flexible accounting system to drive responses when it provides specialized, non-standard, or differentiated services)

From the preliminary explanation and review of the literature described above, the conceptual framework proposed in the study of CMA for waste banks in Indonesia is stated in the following figure:

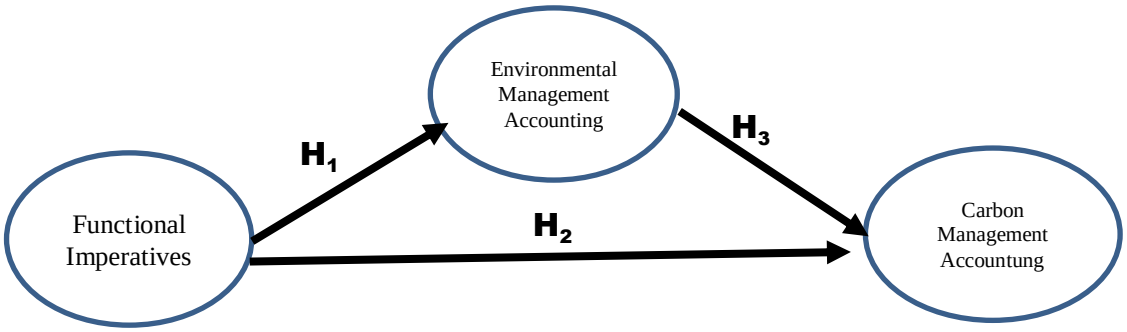


Figure 1. Conceptual Framework

Organizational contextual which can be referred to as FI in environmental management includes environmental uncertainty, local government proactive strategies, and management operations [10] Environmental uncertainty is an unexpected and unpredictable situation around. Uncertainty can cause doubts, indecisiveness, and even confusion. These consequently lead to an inability to interpret or clarify ambiguous information about the environment, which will hinder organizational decision-making processes. The waste management problem has a condition of high environmental uncertainty. The waste problem in Indonesia has become an issue that is quite difficult to solve. This is caused by the increasing population in Indonesia which is not followed by public service facilities related to poor waste management. Local governments need to make strategic efforts in handling waste, especially waste generation. One of the efforts is that minimal waste will be produced, with the lowest possible hazard level during the process of using materials. This effort is a proactive strategy step taken to reduce waste generation. The steps taken by local governments are a part of actions to increase the satisfaction of institutions that impose pressure on them in return for their demands and expectations in line with their goals or strategies. The strategic proactive steps taken in waste management ultimately affect CMA. The more strategic the steps taken, the better the CMA carried out by the local government.

The effect of FI on CMA can be explained by contingency theory. Government action in environmental management, in this case, CMA, depends on environmental uncertainty factors, proactive strategies carried out by local governments, and operational management stated that there is an interaction between local government actions and environmental management activities. The local government communicates with the community regarding environmental policies and issues. Therefore, the better the FI, the better the CMA. From the explanation above, the study hypothesis can be drawn as follows:

H_1: FI have a positive effect on CMA

The broader level of accounting information and timely management information is considered more useful and applicable when organizations face uncertain environments. The managers are more likely to recognize the importance of external, non-financial (i.e. physical), ex-ante (i.e. future-oriented) accounting information than information that is purely financial and ex-post (i.e. historical) in nature when they perceive the organizational environment as highly uncertain. EMA incorporates non-financial, ex-ante, externally oriented information relating to the environmental impact of an organization [23]. Decision-makers tend to use EMA as a reaction to ensure service efficiency and targeted performance results. observed that local governments need to carry out complex procedures and operations for waste and landfill management. Environmental managers are more willing to actively seek new environmental solutions in which EMA has a role to play. [9]revealed that the complex waste operation and service design provides strong incentives for local governments to seek and use the internal and external EMA information in order to monitor services and ensure efficiency or effectiveness. In this case, EMA can be seen to be directly related to the level of complexity of these operational demands. From the explanation above, the study hypothesis can be drawn as follows :

H_2: The FI has a positive effect on EMA

The creation of EMA is a voluntary activity and initiative carried out by corporate entities. Even though it involves a voluntary initiative, implementing such a system provides a means for cost savings and increased profitability by improving company processes, products, as well as services [24] The system facilitates, reduces or even completely eradicate waste, minimize levels of energy use, and reduce the negative impact of a company's operations on the environment. Tan (2005) described the implementation of an environmental management system as a process that systematically establishes, implements, or audits environmental objectives, policies, and responsibilities. Companies with EMA tend to offer more detailed and credible GHG (Green House Gas) emission information compared to those without the system. Therefore, its existence and adoption assist organizations in facilitating the management of GHG reduction strategies. Furthermore, companies pursuing GHG emission reduction strategies are likely to affect CMA. From this description, it can be hypothesized as:

H_3: EMA affects CMA

Based on the empirical study described above, FI has a positive effect on EMA while EMA has a positive effect on CMA. Therefore, indirect hypotheses can be developed as follows:

H4: EMA mediates the positive effect of the FI on CMA

III. METHOD

This quantitative study tested the direct or indirect effect of FI on CMA with EMA as a mediating variable.

The variables used are:

1. The dependent variable was CMA.
   Its measurement was adopted from [25] using 5 dimensions and 16 measurement indicators.
2. The mediating variable was EMA.
   The measurement was adopted from [10] using 3 dimensions, 11 sub-dimensions, and 42 measurement indicators.
3. The independent variable was EMA.

The measurement was adopted from Qian et al (2018) using 3 dimensions and 16 measurement indicators.
All indicator measurements used a Likert scale of 1 to 7 (very dissatisfied to very satisfied). The study population was stakeholders in waste management on Java island. The samples were collected using a purposive sampling technique with certain criteria, namely 1) Head of department/official/employee of the local government who was in charge of waste handling or management, 2) Head of Institution/Company who was responsible for waste management, 3) Third parties who receive waste management permit from the local government, 4) People who work in waste management for at least 1 year. From a total of 1077 questionnaires distributed to stakeholders, 455 samples were successfully collected in complete condition.

The Structural Equation Model Partial Leat Square (SEM-PLS) analysis tool was used to answer the study problems by considering the sample heterogeneity. This model is presented in Figure 2.

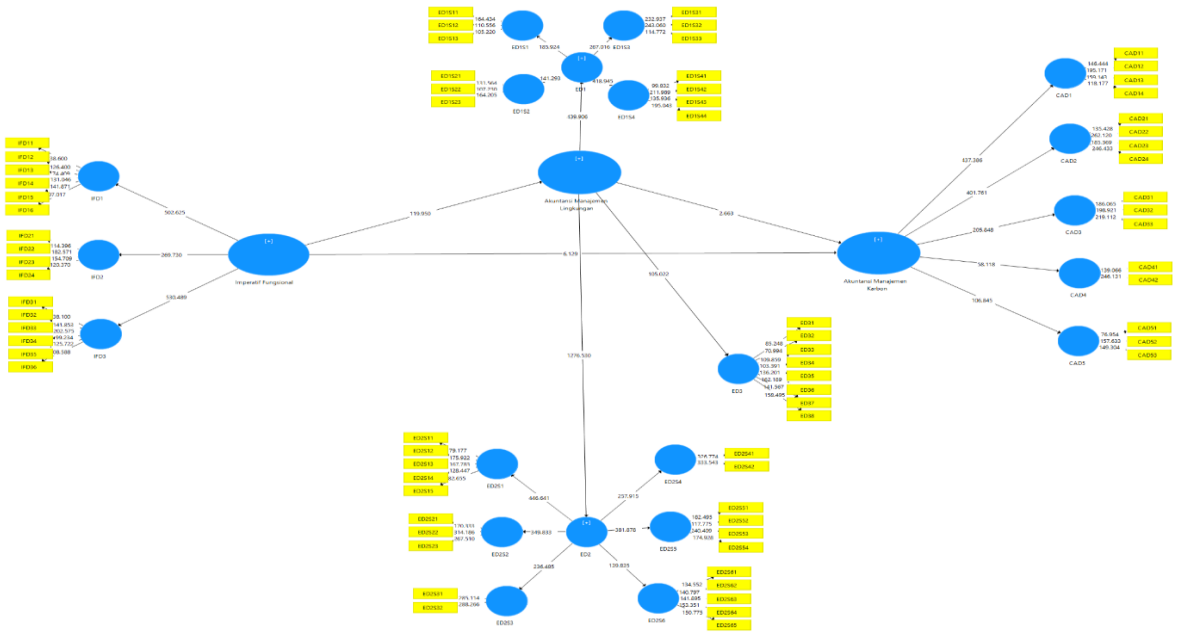


Figure 2. SEM-PLS Model

The stages of processing the model are, 1) conducting an instrument test, namely validity by using outer loading where the indicator is said to be valid when it has outer loading >0.5 and discriminant validity, while the AVE value >0.5

shows the indicators that form interrelated variables. Besides, the reliability test was also conducted, where the indicators are said to be consistent (reliable) when they have a Composite Reliability value of >0.7. 2). The fit model test consisted of a multicollinearity test where each independent variable is free from multicollinearity when it has a VIF value <10. This study also used the adjusted R square test to examine how much the variation of the independent variable can explain that of dependent variable. The value of the adjusted R square lies between 0 to 1. The closer to 1, the fitter the model, while the closer to 0, the less fit. 3) The theoretical hypothesis was also performed by testing the effect of the independent variables on the dependent variable both directly and indirectly. The Ho iss rejected (Ha is accepted) when the p-value of the t statistic is <significant level (α), where the level of significance alpha is 5% and 10%.

IV. RESULT AND DISCUSSION

Based on the validity tests for CMA which consists of 5 dimensions, each indicator is proven valid because it produces an outer loading value > 0.5. Meanwhile, in the validity test for EMA, all indicators that make up the dimensions and sub-dimensions prove valid because they produced an outer loading value > 0.5. Furthermore, the validity test for the FI showed that all indicators are proven valid. Subsequently, all indicators in this study are valid. (source : prosessed data)

The discriminant validity test using AVE for each variable, dimension, or sub-dimension showed an AVE value >0.5. This indicates there is a relationship between each indicator that forms the variable/dimensional/sub-dimensional. Reliability test using Composite Reliability obtained a value of >0.7 for all variables/dimensions/sub-dimensions, hence, all the measurement indicators are consistent (reliable). More detailed information is shown in table 1.

Table 1. Discriminant Validity and Reliability Test

Variables/Dimensions/Sub Dimensions	Average Variance Extracted (AVE)	Composite Reliability
CMA	0.825	0.987
EMA	0.821	0.994
CAD1	0.889	0.970
CAD2	0.912	0.976
CAD3	0.911	0.968
CAD4	0.893	0.943
CAD5	0.859	0.948
ED1	0.819	0.983
ED1S1	0.851	0.945
ED1S2	0.867	0.951
ED1S3	0.901	0.965
ED1S4	0.882	0.968
ED2	0.841	0.991
ED2S1	0.869	0.971
ED2S2	0.921	0.972
ED2S3	0.928	0.963
ED2S4	0.936	0.967
ED2S5	0.890	0.970
ED2S6	0.879	0.973
ED3	0.855	0.979
IFD1	0.854	0.972
IFD2	0.878	0.966
IFD3	0.877	0.977
Functional Imperatives	0.838	0.988

Source: Processed data

The descriptive statistics for CMA obtained an average value of 4.936, meaning that the respondents gave a fairly good response to CMA. Furthermore, the Cultural dimension had the highest average value of 5.105, while Management Cost had the

lowest response of 4.779. Descriptive statistics for EMA produced a fairly good response with an average value of 4.925. The Cost and External effect had the highest response with an average value of 4.873, while Cost and Indirect internal effect had the lowest with 4.730. FI also produced a good response as shown by the average answer value of 5.402. The Proactive Strategy dimension gave the best response with 6.535, while Environmental Uncertainty had the lowest with 4.874. More details are shown in Table 2

Table 2. Descriptive Statistics

Variable and Dimension	Mean	Std. Deviation	Minimum	Maximum
Management Cost	4.799	1.886	1.00	7.00
Measurement	4.870	1.887	1.00	7.00
Technology	4.881	1.872	1.00	7.00
Culture	5.105	1.830	1.00	7.00
Regulation	5.023	1.758	1.00	7.00
CMA	**4.936**	**1.763**	**1.00**	**7.00**
Direct monetary and physical flow of Information	4.776	1.777	1.48	6.88
Indirect internal costs and effects	4.730	1.895	1.00	7.00
External costs and effects	4.783	1.800	1.00	6.79
EMA	**4.925**	**1.748**	**1.00**	**7.00**
Environmental Uncertainty	4.872	1.749	1.00	7.00
Proactive Strategy	6.535	2.361	1.33	9.33
Operational Complexity	4.798	1.803	1.00	7.00
FI	**5.402**	**1.935**	**1.11**	**7.61**

Source: Processed data

The fitness of the SEM-PLS model was examined by testing the coefficient of determination and the results are show in Table 3.

Table 3. Coefficient of Determination Test

Structural Model	R Square	R Square Adjusted
EMA	0.942	0.942
CMA	0.832	0.831

Source: Processed data

EMA had an adjusted R square value of 0.942, meaning that the variation of the independent variable, namely FI, can explain that of dependent variable, namely EMA by 94.2%. The remaining 5.8% is a variation of other independent variables that affect EMA but is not included in the model. CMA model produced an adjusted R square value of 0.831. This means the variation or behavior of the independent variables, namely FI and EMA, can explain that of the dependent variable, namely CMA by 83.1% while the remaining 16.9% is a variation of other independent variables that affect CMA but are not included in the model. These results indicate that the resulting model has a good fit model.

For the H1 hypothesis, an estimation result of 0.639 was obtained, meaning that an increase in FI will increase CMA and vice versa. The p-value of the t statistic was 0.000<0.05 indicating that Ho was rejected, hence, the hypothesis that FI has a positive effect on CMA was proven. t statistic was Hypothessis 2 examines thhe effect off FI on EMA. The estimated coefficient value of 0.585 indicates a good FI will improve EMA and vice versa. The p-value of the t statistic was 0.000<0.05 meaning that Ho was rejected, and Ha was accepted, hence, the hypothesis that FI hss a positive effect on EMA was proven.

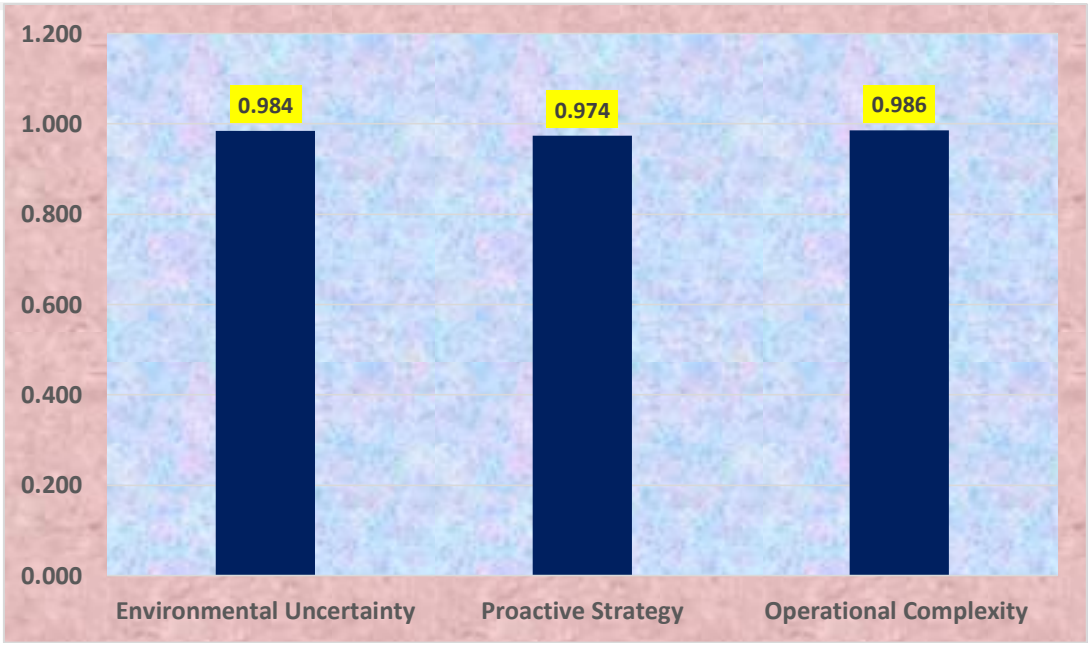
Hypothesis 3 tests the positive effect of EMA on CMA. The processing results obtained an estimated coefficient value of 0.281 indicating that good EMA will produce good CMA as well and vice versa. The p-value of the t statistic was 0.004<0.05, meaning Ho was rejected. Therefore, the hypothesis stating that EMA has a positive effect on CMA was proven. The results of the indirect hypothesis tests, namely the effect of FI on CMA with EMA as a mediating variable, prove the proposed hypothesis as shown by the estimated coefficient value of 0.165 with the p-value of the t statistic of 0.005<0.05. Detailed information is shown in table 3.

Table 4. Hypothesis Test

	Hypothesis Description	Estimate	C.R.	p-value	Conclusion
H_1	FI have a positive effect on CMA	0,639	6,079	0,000	The hypothesis is supported
H_2	FI has a positive effect on EMA	0,585	9,656	0,000	The hypothesis is supported
H_3	EMA has an effect on CMA	0,281	2,650	0,004	The hypothesis is supported
H_4	EMA mediates the positive effect of the FI on CMA	0,165	2,553	0,005	The hypothesis is supported

Source: Data Processing

The results above indicates that FI effectively stimulates EMA and CMA. It also shows the stakeholders, namely the waste bank manager and the government as the party that becomes the regulator, have carried out their duties properly and efficiently. Therefore, the achievement of the expected performance targets is following the roles assigned, especially those related to environmental uncertainty. The SEM model showed that three dimensions of FI made a significant contribution to the formation of FI. Operational Complexity gave the greatest contribution as indicated by the estimated coefficient value of 0.986, followed by Environmental Uncertainty with 0.984, while the lowest was proactive strategy with 0.974 as shown in Figure 3.

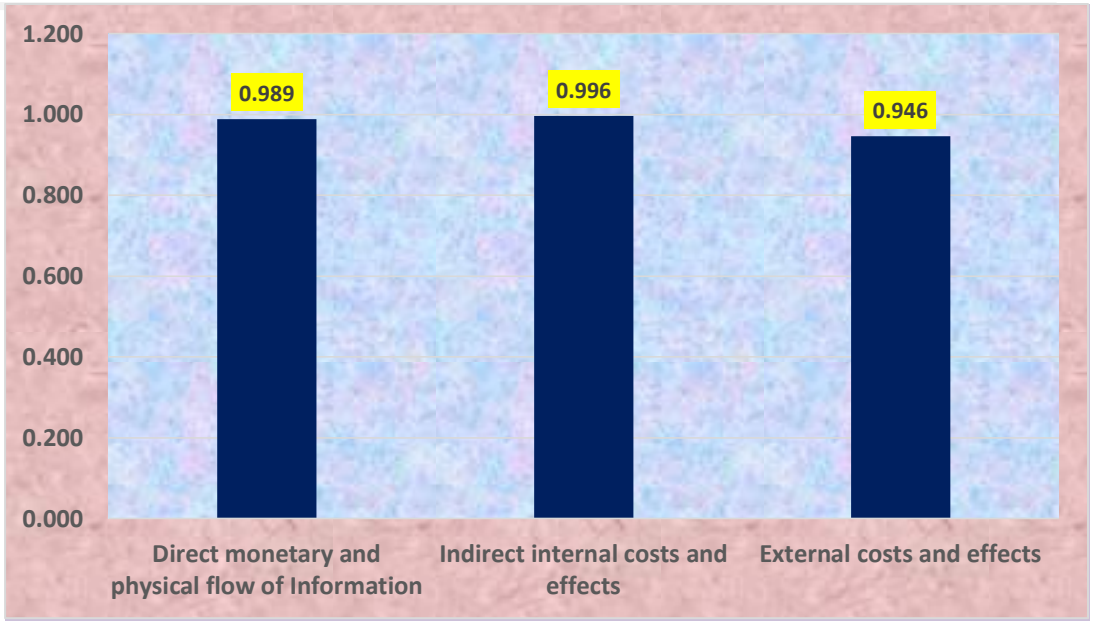


Source: Processed data

Figure 3. Functional Imperative Contribution Coefficient

Referring to hypothesis tests, EMA had an effect on CMA and mediated the effect of FI on CMA. This shows that stakeholders from both waste bank managers and the government have properly used financia l as well as nonn-f inancial information in improving environmental and economic performance.

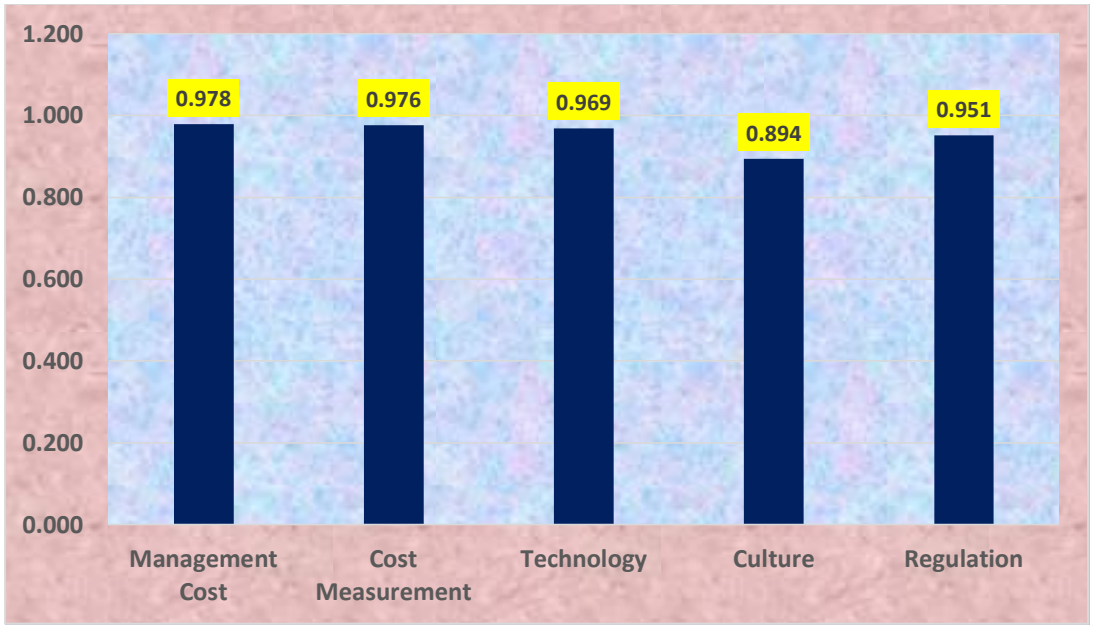
To achieve a sustainable economic business, of the 3 dimensions forming CMA, costs and indirect internal effects (recycling waste collection costs and costs for waste bank education, waste bank management administration fees, and costs for FDS) are minimized through recycled waste. Costs and indirect internal effects produced the largest contribution coefficient of 0.996, followed by direct monetary and physical information flow dimensions of the total waste collected (costs incurred for waste collection, and collection of recyclable waste) with a contribution coefficient of 0.989. The cost and external effect had the lowest (the perceived benefits of having a waste bank, the environmental impact resulting from the existence of a garbage bank, and the economic value resulting from the existence of a waste bank) with an estimated coefficient value of 0.946. More detailed information is shown in Figure 4.



Source: Processed data

Figure 4. Contribution Coefficient of Environmental Management Accounting

CMA has been well implemented by waste bank actors as a part of sustainability accounting designed to provide managers with information that will help companies deal with short-term and long-term decisions about carbon emission issues. In this implementation, EMA and FI are the main factors of CMA as proven by the hypothesis above. Based on the CMA dimensions, waste bank management costs.



Source: Processed data

Figure 5. FI Contribution Coefficient

V. CONCLUSION

From the results of research conducted, can be concluded. Firstly, it was found that the Functional Imperatives (FI) had

a positive impact on EMA and CMA. Additionally, the results showed that EMA had a positive effect on CMA and also mediated the positive influence of FI on CMA. All dimensions of FI, EMA, and CMA were found to significantly contribute to the formation of these variables.

Moreover, the study found that the waste bank business in the Java Island region supported the achievement of the triple bottom line concept, which refers to the planet, the people, and profit. The waste bank business helped to protect the environment by reducing carbon emissions, benefiting stakeholders, and ensuring the sustainability of the business.

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