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# Technology Industry Revolution 4.0 and Environmental Performance: The Mediating Role of Environmental Management Accounting

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## ABSTRACT

**Objective** - The study aims to examine the relationship between advanced technology in IR 4.0 and the implementation of Environmental Management Accounting (EMA) and its impact on environmental performance. The research also proposes the mediating effect of EMA that there is an indirect effect of technology IR4.0 and environmental performance through EMA.
**Methodology/Technique** – Online survey questionnaires were used to collect data distributed to the managers of the Malaysian electrical and electronic companies which are members of the Electrical and Electronics Association of Malaysia (TEEAM). Data analysis was performed using Partial Least Squares (PLS) analysis for the hypotheses testing.
**Findings** - The findings confirmed that advanced technology significantly and positively influenced EMA and environmental performance. EMA significantly and positively influenced environmental performance. Evidence of EMA as a mediator was identified in the relation between advanced technology and environmental performance.
**Novelty** - Environmental data with inadequate credibility prevents management from making informed decisions. Technology IR 4.0 is a key to solving EMA issues, enhancing real-time environmental data, and improving the production process, thus leading to efficient environmental management and improved environmental performance. The study was conducted due to insufficient empirical evidence on the employment of IR 4.0 advanced technology in the use of EMA that leads to enhanced environmental performance.
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## 1. Introduction

Sustainability has become crucial currently as stakeholders demand more information regarding the company's environmental and social performance. Gathering eco-efficient data entails a good infrastructure or appropriate system in companies for data collection and sharing in the supply chain.

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Past studies emphasised that advanced technology under Industry Revolution (IR) 4.0 would enhance environmental information. In the contemporary business environment, sustainability and Industry 4.0 are known as the main course in the current system of production, which has driven companies to adopt advanced technologies Industry Revolution 4.0 in improving manufacturing. According to (Caiado & Quelhas, 2020), smart manufacturing often refers to the manufacturing sector that is presently moving towards Industrial Revolution 4.0. Several countries have introduced government programs to encourage the implementation of Industry 4.0 such as 'High Tech Strategy 2020' and 'Industry 4.0' in German, 'Smart Industry' and 'Produktion 2030' in Sweden, 'Future of Manufacturing' in the United Kingdom, and 'Advanced Manufacturing Partnership' in the United States (Dalenogare et al., 2018). In Malaysia, a national policy is known as National Policy on Industry 4.0 (Industry4WRD) was launched on 31st October 2018 with the purpose of transforming the manufacturing sector to be smarter and stronger driven by advanced technology from 2018 to 2025.

A survey conducted by Deloitte on 19 countries resulted in only 14 percent of highest-level executives who are confident that their organisations are prepared to make complete changes related to the full potential of Industry 4.0 technologies, while most of them are using it simply as an instrument to improve the efficiency of existing operations and to reduce costs (Renjen, 2018). Consequently, one of the programs under Industry4WRD encourages companies to go through the Industry4WRD Readiness Assessment to determine and understand their present capabilities and readiness in adopting Industry 4.0 technologies. However, further investigation is essential to examine the way the advanced technology IR 4.0 is integrated into environmental management accounting (EMA) and which process they can support. The manufacturing sector should be able to offer a good return on investment while simultaneously minimising the environmental impact.

EMA is not a totally different system, instead, it provides value-added benefits to the conventional management accounting system to gather valuable data for the companies to enhance their performances and acquire sustainable development. This is because conventional management accounting is insufficient in dealing with environmental issues (Doorasamy & Garbharran, 2015). Conventional management accounting system generally fails to include data on raw materials that have turned into waste as environmental costs. This would result in the underestimation of actual costs. Hence, the use of EMA is considered the answer to the problem and should be applied by companies, especially the highly environmentally sensitive companies. However, according to (R. Burritt & Christ, 2016), there are some weaknesses in EMA such as poor quality of the collected data and measurement problems which can devalue the usefulness of EMA.

Also, according to the authors, there are no direct measures for environmental information. The measurement involves estimation and assumptions that may be exposed to manipulation in order to present a good environmental report to the stakeholders. Moreover, environmental data with inadequate credibility can avert the management from making informed decisions. As previously suggested by (R. Burritt & Christ, 2016), advanced technology under Industry 4.0 might be one of the keys to solving the above-mentioned problems of EMA. Also, prior research by (Beier et al., 2018) on Chinese industrial companies has also shown that the application of the Internet of Things enhances the availability of real-time environmental data like energy consumption as it helps enhance the production process, thus efficiently improving the environmental management of companies. This could be seen as a potential benefit of advanced technology in helping to enhance environmental performance. This study is inspired by the lack of empirical evidence presently available in relation to whether the employment of advanced technology Industry 4.0 enhances the use of EMA and environmental performance.

The main objective of this study is to examine factors that influence EMA adoption to enhance environmental performance. The specific objectives of the research are: (1) to examine the relationship between advanced technology Industry 4.0 and the adoption of EMA, (2) to examine the relationship between the adoption of EMA and environmental performance, and (3) to examine the relationship between

advanced technology Industry 4.0 and environmental performance. This paper is prepared in the following order where the next section provides the integration of the existing literature review on the advanced technology Industry 4.0, EMA, and environmental performance. The section also includes the development of hypotheses based on the review of relevant literature in the research fields, the underlying theories of this study, and the research framework. This is followed by discussing the research methodology, analysis of the data, and results. Finally, there are sections on the discussion of findings, conclusion, limitations of the study, and suggestions for future research.

## 2. Literature Review and Hypotheses Development

The implementation of technology change was found to have effects on management accounting change, which requires a change in the costing system that could meet the competitive business environment (Allahyari & Ramazani, 2011). Early research by (Tayles & Drury, 1994) found that advanced manufacturing technologies during that time have significant effects on changing the management accounting system (MAS) for creating performance measures and control. The study also found that the evolution in MAS should match with the revolution in manufacturing technology to avoid the systems being a hindrance (Mokhtar et al., 2016).

Many prior studies have implemented the contingency theory to explain the relationship between technology and MAS (Zoni et al., 2012) which includes issues concerning the change in MAS that happens through field studies of the contingency theory. (Zoni et al., 2012) found that the ineffectiveness of management accounting practices, the availability of innovative technologies, and innovative practices like the enterprise resource planning system and ABC are sufficient to trigger the change in MAS. The contingency theory is being incorporated to develop the conceptual framework of this study which is depicted in Figure 1.

Prior literature incorporated the theory to examine the technological and the environmental influence on organisational structure (Bruns & Stalker, 1961). (Dechow et al., 2006) elaborated on why management accounting could depend on information technology, thus revealing that technology mediates the relationship between information systems and management accounting. Contemporary management accounting is better understood when linked with information technology as the system conveys the database to create complex accounting calculations (Dechow et al., 2006). (R. Burritt & Christ, 2016) added that the infrastructure in IR 4.0 was designed for digitised businesses that could improve EMA. Specifically, improved data gathering and transferring processes and more chances to use real-time EMA data and communication technologies. (Jasch, 2006) highlighted EMA as the next step in MAS evolution.

As one of MAS, EMA is gradually accepted as a suitable environmental management instrument of environmental management. EMA aids in assimilating a company's environmental and business welfare in a way that reduces the environmental costs or leads to product differentiation that makes the company more competitive. (Vasile & Man, 2012) discussed the current dimension of EMA and stated that when a company implements EMA, this requires two groups of experts: the accounting group and the technological group contributes to the impression that EMA could be affected when there are changes in the technology as the company would need technology experts while implementing EMA.

Besides that, (Bennett et al., 2002) mentioned that to implement EMA effectively, the use of an information system may be involved. Moreover, (Laforest, 2008) stated that it is viable to implement EMA with a system that has an accompanying technology to support environmental management. In addition, contemporary information technologies are needed to ensure the continued use of EMA instruments in daily environmental management (Lang et al., 2005). stated that information technology support in EMA is needed to provide completeness in the environmental data, reduce the complexity of the information, systematic, and

plausibility, while technologies make it possible for environmental information to be viewed by specific users.

According to (R. Burritt & Christ, 2016), advanced technology IR 4.0 with digitised smart network settings makes it possible to access massive quantities of information in real-time, not roughly calculated, averaged, or affected by human engagement to be used in EMA. Besides that, advanced technology encourages improvement in communication technologies through IoT and CPS that enable the decision-making process to be shared with the respective person by a mutual pool database (R. Burritt & Christ, 2016). Besides, the support from advanced technology enables EMA to identify similar information between the data supply chain and eco-efficient supply chain management (R. Burritt & Christ, 2016). However, since advanced technology Industry 4.0 consists of the latest smart technology, there are scarcities in prior empirical research. As such, this study attempts to examine the relationship between the current advanced technology Industry 4.0 and EMA adoption and environmental performance providing empirical evidence of the electrical and electronics industry, in Malaysia an example of a nation from an emerging economy.

### 2.1 Advanced technology under Industry Revolution 4.0 and Environmental Management Accounting (EMA)

The increasingly available EMA tools are one reason underlying more managers' interest in EMA information. The tools reduce cost and technological barriers in introducing EMA systems. Concerning the presently available advanced technology, (R. Burritt & Christ, 2016) extensively discussed the potential improvement of EMA by applying advanced technology under IR 4.0. The improvements include obtaining better quality environmental information resulting from better accuracy and detailed decision-making purposes, collecting the previously unavailable data, and improving communication links and digital data transfer in real-time.

The researchers suggested that both external environmental accounting and environmental management accounting could be positively influenced by Industry 4.0 technologies. However, not all technology trends will appeal to management accounting. According to (Vaidya et al., 2018), it is a challenge for advanced data analytics to ensure high quality and integration of the data recorded from the manufacturing sector as there are very wide explanations of the data, and it is also increasingly challenging to incorporate diverse data sources. Apparently, there are unlimited amounts of data available internally and externally. There are also worries that advanced technologies such as big data will result in faster wrong decisions than before due to the access to an undirected collection of large amounts of data (Quattrone, 2016). Based on such competing thoughts in prior literature and the acknowledged limitations of prior research in this area, the current study proposes the following hypothesis:

H1: *A positive relationship exists between advanced technology under IR 4.0 and EMA adoption*.

### 2.2 Environmental Management Accounting and Environmental Performance

The EMA received growing attention from managers. Nonetheless, evaluating the relationship between EMA and environmental performance is difficult due to several measuring performance methods. For instance, environmental performance improvement is characterised by a strong intrinsic changeability by examining the absolute reduction of emissions and growing performance movements compared to competitors (Daddi et al., 2011). Most studies depended on environmental managers' observations of the EMA capability in improving environmental performance (Daddi et al., 2011).

The past leading study stated that companies adopt environmental accounting practices only if the companies could enhance financial performance, while rationalists suggested that companies implement the practices to increase sustainability (Springett, 2003). The (International Federation of Accountants [IFAC],

2005) mentioned that EMA assists in identifying the critical environment-related cost information to manage environmental performance effectively. (Iraldo et al., 2009) econometric analysis presented the positive impact of a well-designed environmental management system on environmental performance. Meanwhile, research on Italian companies revealed that environmental performance could create immediate improvement through EMA use (Daddi et al., 2011).

(Phan et al., 2018) examined the connection between specific EMA tools, namely, environmental activity management in Australian organisations based on three levels: environmental activity analysis, environmental activity cost analysis and environmental activity-based costing on environmental performance. The results presented significant relationships between environmental activity management as an essential EMA tool with environmental performance. (Doorasamy & Garbharran, 2015) investigated EMA use and identified environmental costs and the impact on environmental performance. Observably, EMA improves company's environmental and economic performance by providing managers with more precise values of environmental costs. Numerous studies identified the benefits of using EMA on company environmental performance. Therefore, the study proposes the following hypothesis:

H2: *A positive relationship exists between EMA adoption and environmental performance*.

### 2.3 Advanced technology Industry Revolution 4.0 and Environmental Performance

(Wang et al., 2015) stated that organisation's ability in maximising the use of technology technical infrastructure flexibility allows information technologies and the environmental management processes to incorporate better in enhancing the environmental performance. (Watson et al., 2010) clarify that technology infrastructure helps in monitoring, analysing, and streamlining business processes in terms of environmental performance. Thus, improving the effectiveness of environmental management processes.

In the discussion by (Nguyen et al., 2018), digital technologies influence environmental performance by providing practical information processing to assist in the production planning and control decision. The particular reason is advanced technology Industry 4.0 enable organisation to structure the IoT, cloud computing, big data, and analytics to gather and process related data required for manufacturing more effectively and efficiently (Dubey et al., 2019). Findings from empirical research by (Li et al., 2020) also found positive impact of digital technologies Industry 4.0 on economic performance. Thus, in the similar manner, the current study proposes the following hypothesis:

H3: *A positive relationship exists between advanced technology under IR 4.0 and environmental performance*.

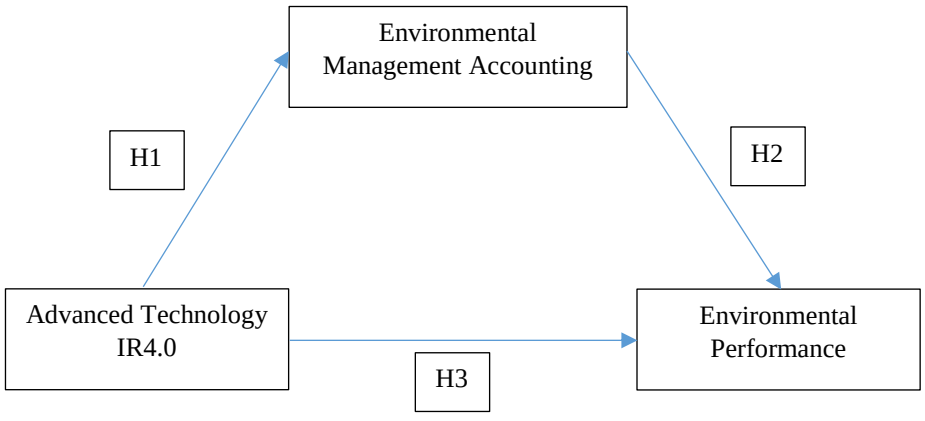



Figure 1. The Conceptual Framework

## 3. Research Methodology

### Questionnaire Survey

The study employed the primary data collection method by distributing questionnaires to the respondents. The questionnaires were prepared on Google Form and emailed to electrical and electronic companies, members of The Electrical and Electronics Association of Malaysia (TEEAM). Based on the official website, TEEAM has a total of 679 members which can be categorised into three types of business activities. There are 325 engineering constructions and service members, 115 manufacturing members, and 239 trading members. This study focuses only on the manufacturing members in TEEAM. Based on the rule of thumb, a sample size of more than 30 and less than 500 is sufficient and appropriate for most studies (Roscoe, 1975) (Sekaran & Bougie, 2016). The simple random sampling technique was sampling technique used in this study is to encourage unbiased random selection. The respondents were individual managers who are involved in management accounting matters to ensure data reliability. Only 75 out of the 115 questionnaires were returned, representing a 65% response rate. The response was considered slow as the data was collected during the COVID-19 pandemic. Thus, the respondents were ensured that all information provided would be treated with confidentiality and to be used for academic purposes only. Since this study was carried out during the movement control order in the year 2020, many companies were not operating during this period, therefore, the duration given to the respondents to answer the questionnaires was eight weeks. Follow-up emails were carried out after four weeks as a reminder. Nevertheless, (Cooper et al., 2001) already emphasised that mail questionnaires with a response rate of approximately 30% are considered acceptable.

### 3.1 Data Analysis

The study used Statistical Package for Social Sciences (SPSS) version 23.0 for the descriptive statistics analysis and Partial Least Square (PLS) to determine preliminary analysis results and hypothesis testing. The questionnaire adopted past research-validated survey instruments.

### 3.2 Variable Measurements

### 3.21 Advanced technology

The advanced production technology is an innovative technology that enhances manufacturing company performance. Advanced production technology implementation significantly impacted management accounting practices (Nain et al., 2017). Advanced technology under IR 4.0 is measured according to five sub-dimensions (big data, smart factory, CPS, IoT and interoperability) adopted from (Imran et al., 2018) 21 items. The questions follow a five-point Likert scale ranging from (1) “strongly disagree” to (5) “strongly agree”. Big data is one of the keys to IR 4.0 and its application through IoT aligns with environmental sustainability (Bibri, 2018). (Saggi & Jain, 2018) highlighted those big data analytics implies more than ‘game-changing’ opportunities to finance professionals and accountants as the term denotes an information source that impacts company financial performance.

(Lee et al., 2014) noted that CPS implementation enables information to be thoroughly observed and synchronised between the factory physical assets and the cyber computational space to increase the manufacturing industry efficiency. The study also includes interoperability as an element to measure advanced technology as (Lu, 2017) summarised that IR 4.0 integrates the nine pillars and an interoperability process. (Chen et al., 2008) defined interoperability as “the ability for two systems to understand one another and to use the functionality of one another”. (Imran et al., 2018) and (Lu, 2017) mentioned that interoperability in IR 4.0 is significant for the production and services industry as the interaction acts as a

framework to facilitate advanced technologies. Thus, all the advanced technology elements are interrelated to function effectively in the company.

### 3.22 Environmental Management Accounting

The EMA includes physical and monetary EMA. The items for environmental costs represent monetary EMA, such as identification, classification and allocation and the uses of environmental costs. Meanwhile, the items for physical EMA are the product inventory analysis, product impact and product improvement. Based on the EMA framework by (R. L. Burritt et al., 2002), (Jalaludin et al., 2011) emphasised the cost tracking, cost tracing, cost treatment, earnings, and savings incurred regarding the company environment-related activities in measuring EMA adoption level. Past studies suggest that the items used to measure the extent of EMA usage are generally similar (Latan et al., 2018) (Christ & Burritt, 2013; Ferreira et al., 2010) (Phan et al., 2018). The present study adopted questions from (Latan et al., 2018) to measure the extent of EMA implementation using 13 items to determine whether EMA provides companies with useful environmental information. The data collected are based on a five-point Likert scale ranging from (1) "strongly disagree" to (5) "strongly agree".

### 3.23 Environmental Performance

Studies present no standard measurement of environmental performance due to the various forms of measurements used (Latan et al., 2018). Past studies measured environmental performance based on the firm level of pollution emissions (Stanwick & Stanwick, 1998). Meanwhile, (Lisi, 2015) assessed environmental performance according to the environmental impact (environmental regulatory compliance and limitation of environmental impact beyond compliance). (Nazari et al., 2017) evaluated environmental performance through the narrative complexity of the corporate social responsibility (CSR) report. The study measured environmental performance based on (Latan et al., 2018) as the instrument is more precise considering various aspects, including compliance with the existing environmental regulation, environmental impact, and environmental management benefits. Specifically, the instrument comprises seven items and is based on a five-point Likert scale ranging from (1) "strongly disagree" to (5) "strongly agree".

## 4. Results

### 4.1 Descriptive Analysis

Table 1 depicts the overall mean score, standard deviation, and actual range of scores for each study variable. The overall mean score for advanced technology under IR 4.0, EMA, and environmental performance was 3.75, 3.47, and 3.82, respectively.

Table 1: Descriptive Statistics of the Main Variables (n = 75)

| Variables | Mean | SD | Actual Range | | Theoretical Range | |
|---|---|---|---|---|---|---|
| | | | Min | Max | Min | Max |
| **ADT** | 3.75 | 0.71 | 2.00 | 5.00 | 1.00 | 5.00 |
| **EMA** | 3.47 | 0.86 | 2.00 | 5.00 | 1.00 | 5.00 |
| **EP** | 3.82 | 0.86 | 1.14 | 5.00 | 1.00 | 5.00 |

Note: ADT = advanced technology under IR 4.0, EMA = environmental management accounting, EP = environmental performance

### 4.2 Validity and Reliability

The measurement model assessed the reliability and validity of the variables. Each variable indicated factor loading on respective constructs, including advanced technology, EMA, and environmental performance. The results in Table 2 suggest satisfactory reliability and validity. The factor loadings exceeded 0.6, which denoted satisfactory individual item reliability (Chin et al., 2003). The results also suggested satisfactory construct reliability as the composite reliability exceeded 0.7. The data was analysed for convergent validity and discriminant validity. For the convergent validity test, Table 2 presents the average variance extracted (AVE) was at least 0.555, indicating that more variance on the construct was explained instead of unexplained (Fornell & Larcker, 1981). Thus, the results described the acceptability of convergent validity for the respective reflective constructs.

Table 2: Measurement Model Properties

| | Indicators | Factor loadings | Composite reliability | Average variance extracted | Cronbach's alpha |
|---|---|---|---|---|---|
| Advanced Technology | ADT1 | 0.848 | 0.963 | 0.555 | 0.961 |
| | ADT2 | 0.807 | | | |
| | ADT3 | 0.813 | | | |
| | ADT4 | 0.621 | | | |
| | ADT5 | 0.798 | | | |
| | ADT6 | 0.700 | | | |
| | ADT7 | 0.796 | | | |
| | ADT8 | 0.808 | | | |
| | ADT9 | 0.796 | | | |
| | ADT10 | 0.642 | | | |
| | ADT11 | 0.824 | | | |
| | ADT12 | 0.697 | | | |
| | ADT13 | 0.734 | | | |
| | ADT14 | 0.840 | | | |
| | ADT15 | 0.863 | | | |
| | ADT16 | 0.744 | | | |
| | ADT17 | 0.616 | | | |
| | ADT18 | 0.705 | | | |
| | ADT19 | 0.651 | | | |
| | ADT20 | 0.630 | | | |
| | ADT21 | 0.605 | | | |
| Environmental Management Accounting | EMA1 | 0.884 | 0.979 | 0.785 | 0.979 |
| | EMA2 | 0.803 | | | |
| | EMA3 | 0.847 | | | |
| | EMA4 | 0.930 | | | |
| | EMA5 | 0.873 | | | |
| | EMA6 | 0.830 | | | |
| | EMA7 | 0.896 | | | |
| | EMA8 | 0.907 | | | |

| | | | | | |
|---|---|---|---|---|---|
| | EMA9 | 0.890 | | | |
| | EMA10 | 0.899 | | | |
| | EMA11 | 0.949 | | | |
| | EMA12 | 0.947 | | | |
| | EMA13 | 0.847 | | | |
| Environmental Performance | EP1 | 0.874 | 0.963 | 0.789 | 0.963 |
| | EP2 | 0.823 | | | |
| | EP3 | 0.839 | | | |
| | EP4 | 0.940 | | | |
| | EP5 | 0.842 | | | |
| | EP6 | 0.925 | | | |
| | EP7 | 0.962 | | | |

Discriminant validity was assessed in two ways: (1) Cross loading and (2) Fornell-Larcker Criterion. Table 3 illustrates that all indicators load at higher values on the specific measured construct than on other constructs, thus confirming the discriminant validity of the construct. Additionally, Table 4 depicts the square root AVE values as presented by the shaded numbers on the leading diagonal exceeding the correlation of the construct. The results also presented the satisfactory discriminant validity of the constructs.

Table 3: Cross Loading (n = 75)

| | ADT | EMA | EP |
|---|---|---|---|
| ADT1 | 0.848 | 0.448 | 0.644 |
| ADT2 | 0.807 | 0.466 | 0.706 |
| ADT3 | 0.813 | 0.442 | 0.344 |
| ADT4 | 0.621 | 0.304 | 0.325 |
| ADT5 | 0.798 | 0.380 | 0.314 |
| ADT6 | 0.700 | 0.316 | 0.118 |
| ADT7 | 0.796 | 0.564 | 0.266 |
| ADT8 | 0.808 | 0.494 | 0.512 |
| ADT9 | 0.796 | 0.341 | 0.252 |
| ADT10 | 0.642 | 0.179 | 0.184 |
| ADT11 | 0.824 | 0.565 | 0.491 |
| ADT12 | 0.697 | 0.344 | 0.052 |
| ADT13 | 0.734 | 0.524 | 0.417 |
| ADT14 | 0.840 | 0.718 | 0.503 |
| ADT15 | 0.863 | 0.488 | 0.383 |
| ADT16 | 0.744 | 0.530 | 0.408 |
| ADT17 | 0.616 | 0.214 | 0.079 |
| ADT18 | 0.705 | 0.388 | 0.183 |
| ADT19 | 0.651 | 0.216 | 0.051 |
| ADT20 | 0.630 | 0.170 | 0.013 |
| ADT21 | 0.605 | 0.186 | 0.150 |
| EMA1 | 0.429 | 0.884 | 0.442 |
| EMA2 | 0.599 | 0.803 | 0.334 |
| EMA3 | 0.423 | 0.847 | 0.433 |
| EMA4 | 0.446 | 0.930 | 0.481 |
| EMA5 | 0.520 | 0.873 | 0.419 |
| EMA6 | 0.306 | 0.830 | 0.320 |
| EMA7 | 0.452 | 0.896 | 0.503 |
| EMA8 | 0.424 | 0.907 | 0.509 |

| | | | |
|---|---|---|---|
| EMA9 | 0.717 | 0.890 | 0.498 |
| EMA10 | 0.637 | 0.899 | 0.545 |
| EMA11 | 0.550 | 0.949 | 0.509 |
| EMA12 | 0.559 | 0.947 | 0.498 |
| EMA13 | 0.538 | 0.847 | 0.547 |
| EP1 | 0.371 | 0.517 | 0.874 |
| EP2 | 0.334 | 0.466 | 0.823 |
| EP3 | 0.521 | 0.318 | 0.839 |
| EP4 | 0.539 | 0.510 | 0.940 |
| EP5 | 0.466 | 0.464 | 0.842 |
| EP6 | 0.399 | 0.445 | 0.925 |
| EP7 | 0.454 | 0.560 | 0.962 |

Table 4: Construct means, standard deviation and intercorrelations from the measurement model

| Variable | Mean | SD | Correlation | | |
|---|---|---|---|---|---|
| | | | ADT | EMA | EP |
| ADT | 0.963 | 0.555 | 0.745 | | |
| EMA | 0.979 | 0.785 | 0.588 | 0.886 | |
| EP | 0.963 | 0.789 | 0.498 | 0.532 | 0.888 |

Note: ADT = Advanced Technology; EMA = Environmental Management Accounting; EP = Environmental Performance

## Hypotheses Testing

Partial Least Square (PLS) analysis was used for hypotheses testing, structural model evaluation, and determining the mediating effect. Table 5 and Figure 2 summarise the PLS analysis results including the path coefficients and path significance for the study framework. The t-values confirmed the significance of H1 (ß = 0.589), H2 (ß=0.365) and H3 (ß = 0.283). The relationship between advanced technology (ADT) and EMA was positive and significant (ß = 0.589, $p < 0.01$, t = 8.017). Additionally, the relationship between EMA and environmental performance was positive (ß = 0.365, $p < 0.01$, t = 2.735). The results also indicated a positive relationship between advanced technology and environmental performance (ß = 0.283, $p < 0.01$, t = 2.206). Thus, H1, H2, and H3 are supported.

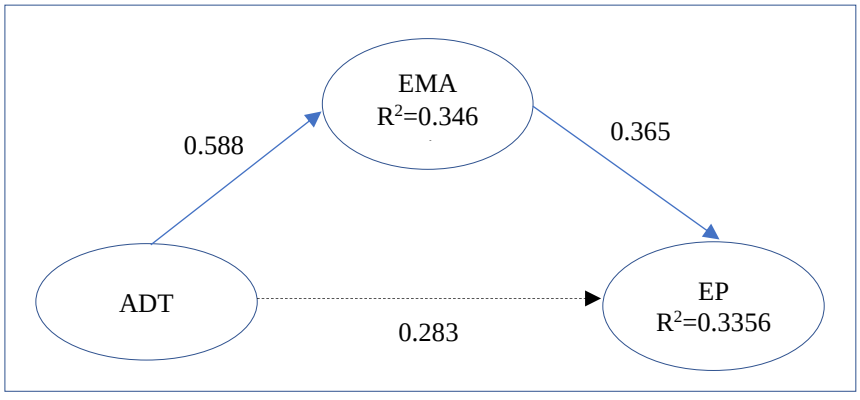



Figure 2: The PLS Analysis Summary

Table 5: Path Coefficient and PLS Structured Model Results

| Hypothesis | Path | Path coefficient | t value | Results |
|---|---|---|---|---|
| H1 | ADT -> EMA | 0.589 | 8.017 | Supported |

| | | | | |
|---|---|---|---|---|
| H2 | EMA -> EP | 0.365 | 2.735 | Supported |
| H3 | ADT -> EP | 0.283 | 2.206 | Supported |

Advanced technology explained 34.6% of the variance in EMA, whereas 33.6% of the variance in environmental performance is explained by EMA and advanced technology. The mediating effect between advanced technology and environmental performance was tested using the (Baron & Kenny, 1986) procedure. The procedure describes that full mediation is identified if (1) the connection between an independent variable (advanced technology) and a dependent variable (environmental performance) is not significant. Nonetheless, (2) the link between the independent variable and the mediator (EMA) is significant so as (3) the link between the mediator and dependent variable.

The Baron and Kenny procedure suggests partial mediation exists if all the links are significant including the link between independent and dependent variables. Table 6 summarises the results of the mediation test. Before adding the mediator (EMA), the direct relation between ADT and EP was positive and significant (ß = 0.550; t = 8.075). The mediation test involved adding EMA to the path analysis. The indirect relationship suggested that the relationship between ADT and EMA was significant (ß = 0.5886; t = 8.017) similar to the relationship between EMA and EP (ß = 0.365; t = 2.735). The direct relationship between ADT and EP was also positive and significant (ß = 0.283; t = 2.206).

Table 6: Direct and Indirect Effects

| Path | Direct Relationship | Partial Mediated Relationship | $R^2$ |
|---|---|---|---|
| n = 75<br>Mediator | | EMA | |
| Effect on environmental performance | | | |
| ADT > EP | 0.550(8.075) | 0.283(2.206) | 0.302 |
| EMA > EP | | 0.365(2.735) | 0.336 |
| Effect on EMA | | | |
| ADT > EMA | | 0.589(8.017) | 0.346 |

## 5. Discussion

### 5.1 Advanced technology under Industry Revolution 4.0 and EMA

The results suggested a positive and significant relationship between advanced technology under IR 4.0 and EMA, hence supporting H1. Based on the beta coefficient in Table 6, the increasingly advanced technology in IR 4.0 increases EMA adoption. Hence, advanced technology in IR 4.0 produces a significant positive linear impact on EMA adoption. The statistical result of advanced technology under IR 4.0 aligns with the contingency theory used in past studies on technology and MAS (Haldma & Lääts, 2002) (Zoni et al., 2012). (Haldma & Lääts, 2002) proposed that accounting system design effectiveness depends on whether the system could adapt to the technology changes as an internal contingency. Additionally, (Maria do Céu, 2010) suggested an increase in the use of accounting information with a higher degree of information technology implemented. The result implied that advanced technology IR 4.0 has gradually gained acceptance in the electrical and electronics industry in Malaysia.

As mentioned by (Lang et al., 2005), it is important for companies to adopt appropriate technology to obtain relevant, accurate, and integrated environmental information for effective EMA adoption. Although IR 4.0 is considered a recent revolution in Malaysian manufacturing companies, this study has shown that the general implementation of advanced technology IR 4.0 in electrical and electronic companies is correlated

with EMA adoption. The computerisation of manufacturing under IR 4.0 has been regarded as enabling the horizontal and vertical system integration among departments, functions, and capabilities to become more systematic and organised. Management accounting will also be benefited from these system integrations by allowing EMA to work in real-time and adjust and learn as the quality of environmental data is improved to be real-time and integrated (R. Burritt & Christ, 2016). Advanced technology IR 4.0 like big data and analytics, IoT, and CPS make it possible for sophisticated accounting systems like EMA to address specific management needs. This is because it provides important computational resources where monetary and non-monetary information has been automatically interpreted into meaningful and accurate data. However, large manufacturing companies and multinational groups may take time to adjust advanced technology IR 4.0 due to the complexity in adapting to the existing systems.

### 5.2 Environmental management accounting and environmental performance

The results in Table 6 illustrate that EMA influences environmental performance. The beta coefficient values indicate a positive and significant relationship between EMA and environmental performance; therefore, H2 is supported similar to (Doorasamy & Garbharran, 2015). The result implies that effective EMA improves environmental performance by monitoring environmental costs during the business operation, monitoring the use and costs of natural resources, and ensuring that capital investment decisions include environmental information. The EMA information improves the management response to external pressures. The ability of EMA to identify the critical environment-related cost information helps manage environmental performance effectively (Doorasamy & Garbharran, 2015) (International Federation of Accountants [IFAC], 2005). The result of this study is in line with several prior studies where environmental performance was found to be significantly impacted by EMA practices (Appiah et al., 2020; Christine et al., 2019) (Latan et al., 2018) (Doorasamy & Garbharran, 2015).

(Latan et al., 2018) stated that the information produced from EMA is used for decision-making for constant improvement in environmental performance. Meanwhile, Christine et al. (2019) mentioned that EMA adoption can provide internal and external data related to the environment and it is used to support not only environmental decisions but also the decisions made by corporations. This association is also favored by Appiah et al. (2020), who stated that EMA is a very significant part in attaining perfect environmental performance. One of the reasons is that EMA makes it possible to evaluate performance through a company's environmental performance analysis system based on financial and non-financial indicators provided by EMA (Appiah et al., 2020).

### 5.3 Advanced technology in Industry Revolution 4.0 and environmental performance

The results in Table 6 suggest that advanced technology under IR 4.0 affects environmental performance. Based on the beta coefficient, the increase in the advanced technology in IR 4.0 increases environmental performance. Resultantly, the more extensive the advanced technology adoption by the company, the more the company can enhance environmental performance; thus, H3 is supported. The results are consistent with (Nguyen et al., 2018) who identified the link between digital technologies and environmental performance. Information processing and planning and control decisions improved when incorporating digital technologies into the business operation. Additionally, digital technologies such as IoT, cloud computing, big data, and analytics would lead to effective and efficient data gathering and processing for manufacturing. The quality of environmental data improved which contributes to improving the environmental performance (Dubey et al., 2019) (Watson et al., 2010). Improvement in the quality of environmental information and environmental management process is due to the more structured business process. According to (Wang et al., 2015), advanced technology promotes environmental management processes. The flexibility in technology technical

infrastructure allows the utilisation of information advanced technologies and environmental management processes which will help to improve environmental performance.

Table 6: Hypotheses and Findings Summary

| Hypotheses | | Finding |
|---|---|---|
| H1 | A positive relationship exists between advanced technology under IR 4.0 and EMA adoption. | Supported |
| H2 | A positive relationship exists between EMA adoption and environmental performance. | Supported |
| H3 | A positive relationship exists between advanced technology under IR 4.0 and environmental performance. | Supported |

The study performed additional analysis to test the EMA indirect effects on the relationship between adopting advanced technology under IR 4.0 and environmental performance. (Field, 2013) mentioned that the Sobel test examines the indirect effect of the predictors on the outcome, specifically the environmental performance in the study. The simple linear regression analysis results were used to measure the indirect effect.

Table 7: Indirect Effect Analysis

| Indirect Effect | Indirect Effect Coefficient | Standard Deviation Coefficient | t-value |
|---|---|---|---|
| Advanced technology under IR 4.0 on Environmental Performance through EMA Adoption | 0.311 | 0.089 | 3.509 |

Table 7 presents an indirect relationship between advanced technology in IR 4.0 and environmental performance as the t-value was 3.509, which exceeded 2.33 at $\alpha = 0.01$. The results indicated EMA influence as a mediating variable. Thus, EMA implementation mediates the relationship between the independent and dependent variables in the study.

## 6. Conclusion

The findings from the research provide theoretical and practical implications for the area of research. From the theoretical perspective, the study provides several contributions to the body of knowledge regarding the implementation of EMA. The results present empirical evidence and insight into IR 4.0 that promotes improvement in environmental accounting as highlighted by (R. Burritt & Christ, 2016). Moreover, the findings enhance past studies concerning the advent of advanced technology that benefits business operations and EMA practices by examining the innovative opportunities to use strategically digital technologies. The study also provides empirical evidence and extends the knowledge regarding IR 4.0 in emerging countries such as Malaysia.

Practically, findings from the study encourage the managers of manufacturing companies in the electrical and electronics industry or similar sectors to implement advanced technology and improve EMA practice effectively. In addition, the study contributes to providing support for the aspiration of the Malaysian government by proposing that governmental actions should emphasise environment-related issues and ensure that manufacturing organisations endeavor to achieve environmental sustainability. Lastly, the study encourages other industries, specifically in Malaysia, to adopt IR 4.0 technologies.

Several study limitations must be considered. Firstly, the interpretation of the results and discussion is based on a small sample size. Generally, the survey did not reach the respondents during the data gathering

process due to closed business operations following the coronavirus disease (COVID-19) pandemic. Nonetheless, the sample size is appropriate according to (Sarstedt et al., 2021). The sample size is adequate for a sample in management accounting research, particularly in survey-based studies, despite being below 200.

The study also focused on certain pillars of IR 4.0 technology that was necessary to manufacturing industries in other countries based on past research (Beier et al., 2018) (R. Burritt & Christ, 2016) (Imran et al., 2018). Several companies might not fully implement the advanced technology in the study as IR 4.0 is relatively new in Malaysia. Moreover, IR 4.0 technology knowledge is limited, such as terms or awareness of the advanced technologies to be implemented in companies; thus, the responses might be inaccurate when answering the survey.

Future research should use a mixed-method approach by interviewing managers to obtain further insight into the research area to facilitate respondents in understanding the terms of IR 4.0 technologies and increase data accuracy collected through the survey. The approach should reflect the participants' perspective, which reduces bias in answering the survey to produce better results. Future research should also consider applying longitudinal data to analyse the gradual changes in EMA practices that are affected by IR 4.0 technology.

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## References

Allahyari, A., & Ramazani, M. (2011). Firm technological change and its effects on management accounting change (Case study of Iranian Manufacturing Firms). *Global Journal of Management and Business Research*, *11*(9).

Baron, R. M., & Kenny, D. A. (1986). The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, *51*(6), 1173.

Beier, G., Niehoff, S., & Xue, B. (2018). More sustainability in industry through industrial internet of things? *Applied Sciences*, *8*(2), 219.

Bennett, M. D., Bouma, J. J., & Wolters, T. J. (2002). *Environmental management accounting: Informational and institutional developments* (Vol. 9). Springer Science & Business Media.

Bibri, S. E. (2018). The IoT for smart sustainable cities of the future: An analytical framework for sensor-based big data applications for environmental sustainability. *Sustainable Cities and Society*, *38*, 230–253.

Bruns, T., & Stalker, G. M. (1961). The management of innovation. *Tavistock, London*, 120–122.

Burritt, R., & Christ, K. (2016). Industry 4.0 and environmental accounting: a new revolution? *Asian Journal of Sustainability and Social Responsibility*, *1*(1), 23–38.

Burritt, R. L., Hahn, T., & Schaltegger, S. (2002). Towards a comprehensive framework for environmental management accounting—Links between business actors and environmental management accounting tools. *Australian Accounting Review*, *12*(27), 39–50.

Caiado, R. G. G., & Quelhas, O. L. G. (2020). Factories for the Future: Toward Sustainable Smart Manufacturing. *Responsible Consumption and Production*, 239–250.

Chen, D., Doumeingts, G., & Vernadat, F. (2008). Architectures for enterprise integration and interoperability: Past, present and future. *Computers in Industry*, *59*(7), 647–659.

Chin, W. W., Marcolin, B. L., & Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Information Systems Research*, *14*(2), 189–217.

Cooper, D. R., Schindler, P. S., & Sun, J. (2001). *Business research methods* (Vol. 7). Mcgraw-hill New York.

Daddi, T., Magistrelli, M., Frey, M., & Iraldo, F. (2011). Do environmental management systems improve environmental performance? Empirical evidence from Italian companies. *Environment, Development and Sustainability*, *13*(5), 845–862.

Dalenogare, L. S., Benitez, G. B., Ayala, N. F., & Frank, A. G. (2018). The expected contribution of Industry 4.0 technologies for industrial performance. *International Journal of Production Economics*, *204*, 383–394.

Dechow, N., Granlund, M., & Mouritsen, J. (2006). Management control of the complex organization: relationships between management accounting and information technology. *Handbooks of Management Accounting Research*, *2*, 625–640.

Doorasamy, M., & Garbharran, H. (2015). The Role of Environmental Management Accounting as a Tool to Calculate Environmental Costs and Identify their Impact on a Companyâ€™ s Environmental Performance. *Asian Journal of Business and Management*, *3*(1).

Dubey, R., Gunasekaran, A., Childe, S. J., Papadopoulos, T., Luo, Z., Wamba, S. F., & Roubaud, D. (2019). Can big data and predictive analytics improve social and environmental sustainability? *Technological Forecasting and Social Change*, *144*, 534–545.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics*. sage.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50.

Haldma, T., & Lääts, K. (2002). Contingencies influencing the management accounting practices of Estonian manufacturing companies. *Management Accounting Research*, *13*(4), 379–400.

Imran, M., Hameed, W. ul, & Haque, A. ul. (2018). Influence of industry 4.0 on the production and service sectors in Pakistan: Evidence from textile and logistics industries. *Social Sciences*, *7*(12), 246.

*International Federation of Accountants [IFAC]*. (2005).

Iraldo, F., Testa, F., & Frey, M. (2009). Is an environmental management system able to influence environmental and competitive performance? The case of the eco-management and audit scheme (EMAS) in the European union. *Journal of Cleaner Production*, *17*(16), 1444–1452.

Jalaludin, D., Sulaiman, M., & Ahmad, N. N. N. (2011). Understanding environmental management accounting (EMA) adoption: a new institutional sociology perspective. *Social Responsibility Journal*.

Jasch, C. (2006). Environmental management accounting (EMA) as the next step in the evolution of management accounting. In *Journal of Cleaner production* (Vol. 14, Issue 14, pp. 1190–1193). Elsevier.

Laforest, V. (2008). Applying Best Available Techniques in environmental management accounting: from the definition to an assessment method. In *Environmental Management Accounting for Cleaner Production* (pp. 29–47). Springer.

Lang, C., Heubach, D., & Loew, T. (2005). Using software systems to support environmental accounting instruments. In *Implementing environmental management accounting: Status and challenges* (pp. 143–168). Springer.

Latan, H., Jabbour, C. J. C., de Sousa Jabbour, A. B. L., Wamba, S. F., & Shahbaz, M. (2018). Effects of environmental strategy, environmental uncertainty and top management's commitment on corporate environmental performance: The role of environmental management accounting. *Journal of Cleaner Production*, *180*, 297–306.

Lee, J., Bagheri, B., & Kao, H.-A. (2014). A cyber-physical systems architecture for industry 4.0-based manufacturing systems. *Manufacturing Letters*, *3*, 18–23.

Li, Y., Dai, J., & Cui, L. (2020). The impact of digital technologies on economic and environmental performance in the context of industry 4.0: A moderated mediation model. *International Journal of Production Economics*, *229*, 107777.

Lisi, I. E. (2015). Translating environmental motivations into performance: The role of environmental performance measurement systems. *Management Accounting Research*, *29*, 27–44.

Lu, Y. (2017). Industry 4.0: A survey on technologies, applications and open research issues. *Journal of Industrial Information Integration*, *6*, 1–10.

Maria do Céu, F. (2010). Management accounting and information technology–some empirical evidence. In *Performance Measurement and Management Control: Innovative Concepts and Practices* (Vol. 20, pp. 429–455). Emerald Group Publishing Limited.

Mokhtar, N., Jusoh, R., & Zulkifli, N. (2016). Corporate characteristics and environmental management accounting (EMA) implementation: evidence from Malaysian public listed companies (PLCs). *Journal of Cleaner Production*, *136*, 111–122.

Nain, S., Lajuni, N., & Mail, R. (2017). Management accounting practices: a bibliometric analysis. *Management & Accounting Review (MAR)*, *21*(1), 1–22.

Nazari, J. A., Hrazdil, K., & Mahmoudian, F. (2017). Assessing social and environmental performance through narrative complexity in CSR reports. *Journal of Contemporary Accounting & Economics*, *13*(2), 166–178.

Nguyen, T. V, ZHOU, L., Spiegler, V., Ieromonachou, P., & Lin, Y. (2018). *Big data analytics in supply chain management in supply-chain management: A state-of-the-art literature review*.

Phan, T. N., Baird, K., & Su, S. (2018). Environmental activity management: its use and impact on environmental performance. *Accounting, Auditing & Accountability Journal*.

Quattrone, P. (2016). Management accounting goes digital: Will the move make it wiser? *Management Accounting Research*, *31*, 118–122.

Renjen, P. (2018). Industry 4.0: Are you ready. *Deloitte Review*, *22*, 8–11.

Saggi, M. K., & Jain, S. (2018). A survey towards an integration of big data analytics to big insights for value-creation. *Information Processing & Management*, *54*(5), 758–790.

Sarstedt, M., Ringle, C. M., & Hair, J. F. (2021). Partial least squares structural equation modeling. In *Handbook of market research* (pp. 587–632). Springer.

Sekaran, U., & Bougie, R. (2016). *Research methods for business: A skill building approach*. john wiley & sons.

Springett, D. (2003). Business conceptions of sustainable development: A perspective from critical theory. *Business Strategy and the Environment*, *12*(2), 71–86.

Stanwick, P. A., & Stanwick, S. D. (1998). The relationship between corporate social performance, and organizational size, financial performance, and environmental performance: An empirical examination. *Journal of Business Ethics*, *17*(2), 195–204.

Tayles, M., & Drury, C. (1994). New manufacturing technologies and management accounting systems: some evidence of the perceptions of UK management accounting practitioners. *International Journal of Production Economics*, *36*(1), 1–17.

Vaidya, S., Ambad, P., & Bhosle, S. (2018). Industry 4.0–a glimpse. *Procedia Manufacturing*, *20*, 233–238.

Vasile, E., & Man, M. (2012). Current dimension of environmental management accounting. *Procedia-Social and Behavioral Sciences*, *62*, 566–570.

Wang, Y., Chen, Y., & Benitez-Amado, J. (2015). How information technology influences environmental performance: Empirical evidence from China. *International Journal of Information Management*, *35*(2), 160–170.

Watson, R. T., Boudreau, M.-C., & Chen, A. J. (2010). Information systems and environmentally sustainable development: energy informatics and new directions for the IS community. *MIS Quarterly*, 23–38.

Zoni, L., Dossi, A., & Morelli, M. (2012). Management accounting system (MAS) change: field evidence. *Asia-Pacific Journal of Accounting & Economics*, *19*(1), 119–138.

## Appendix: Survey items

Explanatory statement: We are interested in the extent to which advanced technology IR4.0 contribute to improving the environmental information of your organisation. Please read the statements below and indicate your level of agreement or disagreement with the statement of the advanced technology, environmental management accounting and environmental performance.

Advanced Technology IR4.0 (1: Strongly disagree, 5: Strongly agree)

| **Item** | Label |
|---|---|
| **Big Data and Analytics** | |
| We continuously examine the innovative opportunities for the strategic use of big data analytic. | ADT1 |
| When we make big data analytic investment decisions, we think about and estimate the effect it will have on the productivity of the employee's work. | ADT2 |
| In our organisation, the business analysts and line people meet frequently to discuss important issues. | ADT3 |
| In our organisation, the responsibility for big data analytics development is clear | ADT4 |
| **Smart Factory** | |

| | |
|---|---|
| It offers ways that can successfully address the issues | ADT5 |
| It provides the ability to work in real time | ADT6 |
| It provides the ability to adjust and learn from data | ADT7 |
| It has significant relationship with responsive, proactive and predictive practices which enhance the accuracy | ADT8 |
| It enables the organisation to avoid operational downtime and other productivity challenges | ADT9 |
| **Cyber Physical System (CPS)** | |
| It provides significant computational resources which contributes to operations | ADT10 |
| It enhances the processing capability and local storage | ADT11 |
| It provides unprecedented opportunities for innovation | ADT12 |
| It provides ability to handle challenges, barriers and threats | ADT13 |
| **Internet of Things (IoT)** | |
| It provides lower lead times for customers and lower overall costs | ADT14 |
| It helps to improve production capacity | ADT15 |
| It provides the linkage of all devices to the internet which help production processes | ADT16 |
| It provides better communication between employees | ADT17 |
| It provides a link between customers and company, and increases the customer satisfaction level | ADT18 |
| **Interoperability** | |
| It has the ability to automatically interpret the information exchanged meaningfully and accurately | ADT19 |
| It implies exchange between a range of products, or similar products from several different vendors | ADT20 |
| It provides better technology to boost inter organisational activities | ADT21 |

Environmental Management Accounting (1: Not at all, 5: Large extent)

| **Item** | Label |
|---|---|
| Identification of environmental costs | EMA1 |
| Estimated contingent liabilities relating to the environment | EMA2 |
| Classification on environmental costs | EMA3 |
| Allocation on environmental costs associated with the production process | EMA4 |
| Allocation of environmental costs associated with the product | EMA5 |
| Introduction or improvement to environment-related cost management related cost management | EMA6 |
| The creation and use of environment-related cost accounts | EMA7 |
| Development and use of environment-related key performance indicators | EMA8 |
| Product Life Cycle Cost Assessment | EMA9 |
| Product inventory analyses | EMA10 |
| Product impact analyses | EMA11 |
| Product improvement analyses | EMA12 |
| Assessment of potential environmental impacts associated with capital investment decisions | EMA13 |

Environmental Performance (1: Not at all, 5: Large extent)

| Item | Label |
|---|---|
| Compliance with the requirements or expectations of standard | EP1 |
| Preventing and mitigating environmental crises | EP2 |
| Uncovering cost cutting opportunities | EP3 |
| Limiting environmental impact beyond | EP4 |
| Improved reputation | EP5 |
| Generating social benefits | EP6 |
| Increased competitive advantage | EP7 |