

Evaluating the Critical Success Factors in the Implementation of ISO 14001 Using Analytical Hierarchy Process (AHP) in Malaysia

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Abstract: - - ISO 14001 seeks commitment from industries, multinationals, and governments across the globe to support and develop a formal environmental management system to enhance environmental performance. In this regard, the main objective of this paper is to analyse the critical success factors for the ISO 14001 implementation by industries in Penang, Malaysia, by applying the analytical hierarchy process (AHP). Purposive sampling was used in this study to select 34 companies in Penang certified with ISO 14001. A total of 34 Penang-based companies participated in this study. AHP was performed to determine the relative weights and objectives of these organisations' significant performance variables and gains. The results of the study show that management (0.2694), organisational change (0.2477), external and social aspects (0.2457), and technological aspects (0.2373) are the main success factors for the ISO 14001 implementation. This study makes a new contribution to the ISO14001 implementation by industries in Malaysia. Further, this study provides important information for decision-makers involved in environmental management system implementation and serves as a useful reference for future researchers in the management of environment quality research area.

Key-Words: - Environmental Management System (EMS), ISO 14001, Analytical Hierarchy Process (AHP), Critical Success Factors, Benefits, Malaysia

1 Introduction

ISO 14001 is the global standard that sets the required criteria for an effective Environmental Management System (EMS). It offers companies with a system that complies with environmental performance criteria rather than constructing them [1]. Companies should adopt ISO 14001, which is under the ISO 14000 standard family because it is a suitable standard for all kinds of businesses regardless of their size. ISO 14001 implementation aims to improve support for a company's goals. As far as environmental legislation is concerned, businesses are generally obligated to understand exceptionally well not only the environmental aspects of the supply chain but also the life cycle of their goods. They will conduct sufficient EMS to reduce waste and conserve the environment [2, 3].

For a variety of factors, such as high initial set-up costs, extended time to implement the EMS, lengthy training programmes, and complexities in documentation systems, many organisations face difficulties in adopting ISO 14001 [4]. The early

execution approval process is very costly. Costs are incurred in designing new methods and experiments, purchasing new facilities and instruments mainly for testing and measuring purposes, and analysing results [5].

The critical success factors for the implementation of ISO 14001 can be used to assess the efficacy of ISO 14001 requirements for organisations and to enhance organisations' environmental performance. Management strategy leads to better communication and coordination between the management team and employees. At the same time, organisational reform guarantees clearly defined obligations and their communication to all levels in the organisation [6, 7]. Further, external and social aspects support the organisation, while technological aspects support in tracking and monitoring the activities that lead to adverse environmental impacts [8, 9]. Understanding the importance of EMS (ISO 14001), this study has attempted to review selected literature and their research findings on the ISO 14001 implementation and its critical success factors (CSFs). While the

broad concept of environmental management is commonly accepted, there is a need to fill the gaps between theory and practices for this ISO 14001 implementation, particularly by the Malaysian industries.

2 Literature Review

2.1 The Issues of ISO14001 Implementation

Organisations that implemented the ISO 14001 standard faced problems, including discontent among the workers who complained that the management needed to be more accountable and was reluctant to offer more time and money than required to enforce the EMS. Furthermore, most of the companies made the decision to apply for ISO 14001 because of many governments in developed and developing countries demand the company's environmental responsibility [10]. Besides that, another explanation by previous studies like Silva *et al.* [11], Betancur-Corredor *et al.* [12], and Piyathanavong *et al.* [13] of why most of the companies took the decision to ISO 14001 execution is that they face a challenge in determining the benefits and suffer from unsustainable costs as a result of adverse environmental impacts.

Any company that has successfully adopted the ISO 14001 standard can review and improve their quality of total environmental efficiency. The factors leading to the success of the ISO 14001 implementation may differ among states and can include factors such as administrative law, economic problems, and culture. According to Zutshi and Sohal [14], until the programme is carried out and sustained, a company may face issues whether on efficiency, workplace health and safety, or environmental concerns. ISO 14001 was developed to help organisations control their environmental efficiency. However, other obstacles can prevent an organisation from successfully implementing an EMS, such as the lack of time and resources needed to complete the EMS [15].

Other factors may prevent a company from adopting ISO 14001, for example, the frustration of employees who complain about additional duties and the inability of management to provide time and resources to implement the EMS. Moreover, bureaucracy and the demand for excessive certifications have increased the burden on organisations that intend to implement ISO 14001 [16]. Many organisations are discouraged from

adopting ISO 14001 due to high costs and heavy use of time and resources to adopt this environmental management programme. They claim that the biggest challenge in implementing ISO 14001 are escalations in construction costs and long-term maintenance and development costs. Turk [17] said difficulties in obtaining the ISO 14001 certification are caused by factors such as increased set-up and operational costs, a lack of trained staff, and inadequate certification details.

The primary obstacle to the EMS implementation for Australian and United Kingdom (UK) small- and medium-sized companies is high costs [18]. In fact, several of these companies were not aware of the business benefits of being accredited. Previous research has found that there are human resources limitations for the efficient operation and maintenance of the EMS as contrasted with the lack of monetary capital in small- and medium-sized business [19]. It was also found that the principles of the businesses, which included untrustworthy support from the top management, hindered successful implementation. EMS implementation and changes is a complex process involving a variety of practical meetings. Studies have demonstrated that Estonian companies have engaged in the ISO 14001 planning process, especially concerning environmental aspect assessment (EAA) [20]. This evaluation is the most critical part of the ISO 14001 planning process, as companies need to identify the origins of their activities, products, and services that have adverse impacts on the environment. ISO 14001 only provides common values for EAA applications where been decided by the organisation or company that are imprecise, insufficient, and cannot be improved scientifically [21]. During the planning process, the most significant effort is exerted in identifying the environmental outputs that include the formulation of quantifiable objectives here

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2.1 Critical Success Factors for the ISO14001 Implementation

The key point for the effective design and implementation of ISO 14001 is the management approach (MA), which encompasses the engagement of the top management, acceptable environmental policy, and ongoing management assessments [22]. ISO 14001 requires the participation of all workers and focus on the role of the organisation, and without input from the management team, this standard's adoption cannot be accomplished. The management approach (MA) sub-elements consist of top management commitment and support (TMC), environmental policies and objectives (EPO), and management reviews (MR). Environmental policies provide a framework for the company to set its goals and priorities [6]. The top management participates actively in the policy formulation and ensures that it is passed on to all members of the organisation. The top management will also review the EMS to ensure that the system is acceptable, adequate, and efficient.

The second most significant point in the ISO 14001 implementation is organisational change (OC). Some changes within the organisation should be anticipated when ISO 14001 is being implemented [23]. The sub-components of organisational change (OC) are training and awareness (TNA), documentation and control (DC), response and preparedness in an emergency (ERP), and communication (CM). Effective implementation of ISO 14001 includes clear descriptions and communication of environmental obligations [24]. Education and training are necessary to improve employees' capabilities, and organisations operating ISO 14001 need to establish and maintain processes for the exchange of ISO 14001 information. The process for controlling the necessary documentation

in the company is established and properly maintained to recognise and respond to emergencies as well as to prevent environmental impacts associated with emergency conditions.

The third point in the ISO 14001 implementation concerns the external and social aspects (ENSA) underlining government regulations, market forces, and customer requirements that prompt the organisation to implement ISO 14001. The subsets of ENSA are market forces (MF), government legislation (GR), consumer demand (CD), and employee relationships (RBE). ISO 14001 prompts the organisation to comply with the requirements of the regulation. The emerging regulatory burdens have compelled organisations to establish an inclusive EMS to improve the flexibility of all stakeholders and managers. ISO 14001 has improved organisations' ability to attract highly skilled staff and their loyalty, which indirectly helps improve working relationships within the company, thus leading to a successful EMS implementation [25]. Due to consumer demands that concern climate, many foreign companies are introducing the EMS.

The last critical factor in the ISO 14001 implementation addresses the technical aspects (TA). The effectiveness of ISO 14001 depends on the appropriate monitoring efficiency. The technical aspects (TA) sub-elements are used to improve production (IP), monitoring and measuring equipment (MMEs), and environmental expert aid (EEAs). Companies need expert assistance in recognising and resolving technological challenges in operations that cause major environmental impacts [26]. Consultants help organisations to boost their environmental efficiency and comply with environmental legislation. ISO 14001 implementation requires effective monitoring and measuring equipment for the continuous monitoring and measurement of all activities that have significant impacts on the environment. Control devices can be used to improve manufacturing processes and make them more environmentally friendly.

3 Methodology

3.1 Analytical Hierarchy Process (AHP)

AHP is used to assess the basic significance of a particular project. A project-dependent panel is generated to calculate the weights of elements in any level of the hierarchy, which corresponds to the element in the higher stage so that one element that affects another. For every stage of the hierarchy, the calculation shall be converted to standardised

weights to create a variable weight for the entire hierarchy [27]. The vector estimation corresponds to the priorities of hierarchy at the lowest level. The weights of the respective priorities ensure an equitable distribution of capital in the lower stage of the hierarchy [28].

Byun [29] applied the expanded AHP to pick the car range. The study included two topics: one integrated the contrast with the table technique on a nine-point scale while the other incorporated group weights into the consistency ratio. Tam and Tummala [30] used AHP to select a vendor for a hybrid and multi-criteria decision-making telecommunication system. They considered AHP as very useful in making choices when there are various conflicting factors involved. The outcomes of the procedure are comprehensive, and the time taken to pick the respondent is effective [31]. Noci and Toletti [32] adopted the fuzzy approach to select quality systems. Dong and Yu [33] performed AHP and the fuzzy linguistic approach to implement an individual numerical scale and prioritisation method. AHP consists of four key steps, namely:

- i. Build the question and design a model structure
- ii. Collect and quantify data based on pairwise comparison
- iii. Estimate the standardisation of priorities for each dimension
- iv. Investigate weights and problem-solving goals

The framework of the AHP model consists of five phases (Figure 1). The main phase is the primary goal or purpose of governance. The second and third phases provide the elements that contribute to an efficient ISO 14001 implementation. The factors driving the successful adoption of ISO 14001 are present in second and third phases as suggested by Pun and Hui [34]. The fourth phase consists of the advantages and benefits of a successful ISO 14001 implementation, while the final stage highlights the effects of ISO 14001 implementation, whether or not they are effective. The AHP approach was used in this study to evaluate the efficiency of the ISO 14001 implementation by industries in Penang to determine all of the critical success factors (CSFs). The AHP approach was selected because of the functional nature of the technique that is useful for solving the dynamic and intangible problem in decision-making [35].

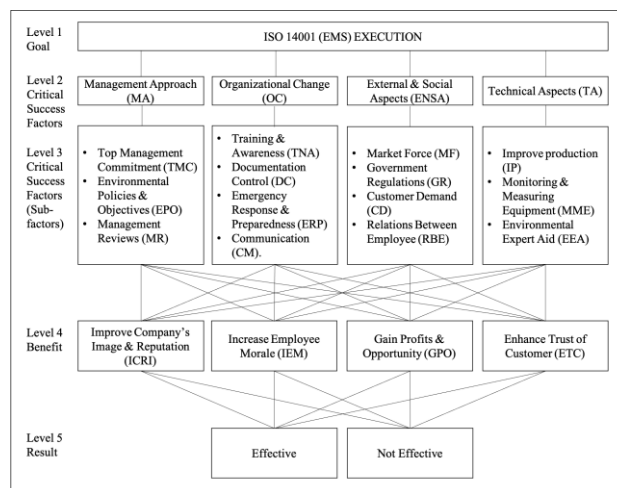


Fig 1. The AHP Framework in ISO 14001 Implementation

3.2 Sampling Technique

This study used the purposive sampling technique, where an unlikely sample is chosen depending on the aim of the study. The sampled system is the database of ISO 14001 accredited industries in Penang, where there are two dominant industries: manufacturing and electronics. At the time the study was conducted, a total of 34 companies were registered with the certification body. The survey was carried out by circulating a questionnaire to all organisations that had the EMS experience.

3.3 Research Instrument

The instrument used in this study is a questionnaire that offers details about the respondents' context and contrast in the individual hierarchy phases of the AHP system. The questionnaire was prepared following the previous research by Pui and Hui [34]. The respondents' history consists of two parts, where the first part covers the respondents' demographic characteristics and the second part deals with the organisation information like size of the organisation, the post-certification period, and level of ISO 14001 certificate body (CB) applied. The comparison segments consist of the key success factors that lead to the success of ISO 14001 execution.

Respondents were required to compare four essential performance elements in pairs, namely management strategy, organisational improvement, external and social aspects, and technical aspects, with 14 sub-elements. The application of the nine-point scale allowed the answers to be translated into figures. Table 1 shows the nine-scale used in analytical hierarchy process. The respondents have the choice to utter selection between the two factors as equally preferred, weakly preferred, strongly

preferred or absolutely preferred which would interpret into pairwise weights of 1,3,5,7 and 9 respectively with 2,4,6 and 8 as intermediate values [36].

Table 1. Nine-point scale used in Analytical Hierarchy Process with Respective Intensity of Importance [27].

| Intensity of importance | Definition | Explanation |
|-------------------------|--|---|
| 1 | Equal importance | Two activities contribute equally to the objective. |
| 3 | Weak importance of one over another | Experience and judgment slightly favor one activity over another |
| 5 | Essential or strong importance | Experience and judgment strongly favor activity over another |
| 7 | Demonstrated importance | An activity is strongly favored, and its dominance is demonstrated in practice |
| 9 | Absolute importance | The evidence favoring one activity over another is of the highest possible order of affirmation |
| 2,4,6,8 | Intermediate values between two adjacent judgments | When compromise is needed |

3 Results and Discussion

4.1 Respondent's Profile

Around 80% of the respondents answered the distributed questionnaires. The respondents' socio-demographic information is shown in Table 2. The questionnaires were completed by company representatives holding the position of Environment Manager, Environmental Officer, Environmental Engineer, or Quality Assurance Manager. Approximately 94% of the companies obtained the ISO 14001 accreditation in the past five years (2015-2020). The company's representatives also informed that other quality systems, such as OHSAS 18001 (32%) and MS 9001 (26%), have been introduced in addition to ISO 14001 and that approximately 85% of globally accredited organisations have applied for ISO 14001.

Table 2: Socio-demographic Profile of Respondents

| Demographic Features | Frequency (%) |
|--|---------------|
| Types of industries: | |
| 1) Manufacturing | 15 (44) |
| 2) Electric and Electronic | 19 (56) |
| Gender: | |
| 1) Male | 19 (56) |
| 2) Female | 15 (44) |
| Age group (years): | |
| 1) 20-30 years old | 14 (41) |
| 2) 31-40 years old | 7 (21) |
| 3) 41-60 years old | 13 (38) |
| Educational level: | |
| 1) Certificate | 3 (8) |
| 2) Diploma | 4 (12) |
| 3) Degree or higher | 27 (80) |
| Position: | |
| 1) Environmental Manager | 7 (21) |
| 2) Environmental Officer | 4 (12) |
| 3) Environmental Engineer | 6 (17) |
| 4) Quality Assurance Manager | 17 (50) |
| ISO Standard certified | |
| 1) ISO 14001: | 14 (42) |
| 2) MS 9001 and ISO 14001 | 9 (26) |
| 3) MS 9001, ISO 14001 and others | 11 (32) |
| Duration of ISO 14001 certification: | |
| 1) < 5 years | 2 (6) |
| 2) > 5 years | 32 (94) |
| Types of certified body applied for ISO 14001 (EMS): | |
| 1) National certified body | 5 (15) |
| 2) International certified body | 29 (85) |

4.2 Analytical Hierarchy Process (AHP) Results

The significant stage in AHP is constructing multiple pairwise comparisons for normalisation. The main concern in using this comparison method is the consistency of pairwise decisions delivered by the respondents. AHP offers a measure of consistency for the pairwise comparisons by computing the consistency ratios. The consistency ratios of the different factors are shown in Table 3. The consistency ratios of all the factors are within the acceptable limit of below 0.10, with the lowest value of 0.001, the highest value of 0.093, and the overall consistency ratio of 0.032. Hence, the matrices are reasonably consistent, and the study can continue with the process of decision making using the AHP method.

Table 3. The consistency ratios for critical success factors

| Success Factors | Consistency Ratio |
|-----------------------------------|-------------------|
| Management Approach (MA) | 0.068 |
| Organizational Change (OC) | 0.064 |
| External and Social Aspect (ENSA) | 0.061 |

| Success Factors | Consistency Ratio |
|---|-------------------|
| Technical Aspect (TA) | 0.093 |
| Top Management Commitment (TMC) | 0.085 |
| Environmental Policies and Objectives (EPO) | 0.001 |
| Management Review (MR) | 0.041 |
| Training and Awareness (TNA) | 0.091 |
| Documentation Control (DC) | 0.010 |
| Emergency Response and Preparedness (ERP) | 0.005 |
| Communication (CM) | 0.004 |
| Market Force (MF) | 0.054 |
| Government Regulation (GR) | 0.032 |
| Customer Design (CD) | 0.041 |
| Relation between Employee (RBE) | 0.080 |
| Improve Production (IP) | 0.035 |
| Monitoring and Measuring Equipment (MME) | 0.012 |
| Environmental Aspect Aid (EEA) | 0.043 |

Table 4 shows the normalised priority weights at stage one. The priority weights of the critical success factors show their relative prominence in the ISO 14001 implementation. MA (priority weight = 0.2694) is found to be the most critical success factor, while the least critical is TA (priority weight = 0.2373). The order of rank for the critical success factors from the most critical to the least is MA (0.2694), OC (0.2477), ENSA (0.2457), and TA (0.2373).

Table 4: The priority weight for main critical success factor

| Success Factors | Weight | | | | Priority |
|-----------------------------------|--------|-------|-------|-------|----------|
| | MA | OC | ENSA | TA | |
| Management Approach (MA) | 0.217 | 0.310 | 0.288 | 0.261 | 0.269 |
| Organizational Change (OC) | 0.287 | 0.235 | 0.229 | 0.238 | 0.247 |
| External and Social Aspect (ENSA) | 0.264 | 0.227 | 0.237 | 0.253 | 0.245 |
| Technical Aspect (TA) | 0.230 | 0.227 | 0.244 | 0.246 | 0.237 |

The standardised marks at stage two show the relative importance of sub-elements for each of the critical success factors identified in stage one. For MA, the order of rank of the sub-elements from the most critical to the least is EPO (0.0803), TMC (0.076), and MR (0.0725). For OC, the order of rank of the sub-elements is TNA (0.0712), CM (0.0682), ERP (0.0674), and DC (0.0653). Meanwhile for ENSA, the order of rank of the sub-elements is MF

(0.0736), RBE (0.0735), CD (0.0714), and GR (0.0672). Finally, for TA, the order of rank of the sub-elements is EEA (0.0724), IP (0.0718), and MME (0.0693). The global priority weights for each of the sub-elements are specified in Table 5, which demonstrates that the topmost five sub-elements comparative to the effective ISO 14001 implementation are EPO (0.0057), TMC (0.0054), MF (0.0053), RBE (0.0053), and MR (0.0052).

Table 5. The global priority weights of sub-factors relative to the goal

| Rank | Success Factors | Priority Weights | Global priority weights |
|------|---|------------------|-------------------------|
| 1 | Environmental Policies and Objectives (EPO) | 0.0803 | 0.0057 |
| 2 | Top Management Commitment (TMC) | 0.076 | 0.0054 |
| 3 | Market Force (MF) | 0.0736 | 0.0053 |
| 4 | Relation between Employee (RBE) | 0.0735 | 0.0053 |
| 5 | Management Review (MR) | 0.0725 | 0.0052 |
| 6 | Environmental Aspect Aid (EEA) | 0.0724 | 0.0052 |
| 7 | Training and Awareness (TNA) | 0.0712 | 0.0051 |
| 8 | Customer Design (CD) | 0.0712 | 0.0051 |
| 9 | Improve Production (IP) | 0.0718 | 0.0051 |
| 10 | Monitoring and Measuring Equipment (MME) | 0.0693 | 0.005 |
| 11 | Communication (CM) | 0.0682 | 0.0049 |
| 12 | Emergency Response and Preparedness (ERP) | 0.0674 | 0.0048 |
| 13 | Government Regulation (GR) | 0.0672 | 0.0048 |
| 14 | Documentation Control (DC) | 0.0653 | 0.0047 |

4.3 Benefits of ISO14001 Implementation

The standardised marks at stage three specify the relative significance of advantages of the ISO 14001 implementation. Table 6 shows the order of rank of advantages from the highest to the lowest, starting from ICRI (0.260) and followed by ECT (0.255), GPO (0.245), and IEM (0.240). The standardised marks at stage four show the relative effectiveness of the ISO 14001 implementation. The order of rank for effectiveness is the same as the order of rank for advantages. Based on these marks and priority

weights at other stages, the overall effectiveness of the ISO 14001 implementation is 0.25.

Table 6. The benefits of ISO 14001 implementation

| Benefits | Priority Weight |
|---|-----------------|
| Improve Company's Image and Reputation (ICRI) | 0.260 |
| Increase Employee Morale (IEM) | 0.240 |
| Gain Profits and Opportunity (GPO) | 0.245 |
| Enhance Trust of Customers (ECT) | 0.255 |

4.4 Discussion

This study found that the management approach is the most significant critical success factor for the system. According to Waxin *et al.* [37], the ISO 14001 standard needs commitment and encouragement from the top management for it to be successfully implemented. Management commitment starts with the environmental plan and followed by relaying the message to all employees. In addition, this study shows that organisational change is the second most important aspect of company performance in environmental management. Proper implementation of ISO 14001 requires improvements within an organisation with clearly specified activities and the organisation's ability to respond to emergencies such as environmental disturbances. These include adequate training and an increase in workforce awareness of the environment [24].

The third most critical success factor identified in this study is the external and social aspects that encourage the ISO 14001 execution. The growing emphasis by consumers and other stakeholders to companies to prove their commitment to the environment and ISO 14001 certification provides the best push for companies to demonstrate such commitment. The standard also assists companies to do business in the global market which demanding for more environmentally friendly products or services [8].

This study also revealed that the least critical success factor in the adoption of ISO 14001 by industries in Penang is the technical aspect. According to Knight and Jenkin [26], the manufacturing cycle needs to be strengthened by sufficient equipment and technologies to make the whole cycle greener. Nonetheless, routine monitoring needs to be carried out with the use of suitable testing and measurement equipment. Some organisations do not have the expertise to develop and execute the EMS, and hence, the help provided by an environmental expert in the implementation of ISO 14001 is important.

This study revealed that the most important advantages or benefits of the ISO 14001 implementation are in boosting the reputation and image of the company. This finding is in line with Tan [38], where a company's commitment to environmental protection boosts the image of the company in the eyes of consumers and suppliers. The emphasis on building the image of the company helps to improve the operations and also increase the efficiency and product features. Next, the second most important advantage of the ISO 14001 implementation is in improving consumer loyalty and trust. Consumers are becoming gradually aware of environmental protection, and they choose the suppliers with an excellent environmental track record [8]. The ISO 14001 standard helps to build consumers' trust as well as maintain consumer loyalty towards the company.

The third most crucial advantage identified in this study is in gaining profit and new business opportunities with other companies. The enhancements in operations help to reduce harmful discharge, decrease waste generation, and prevent the occurrence of environmental mishaps [6]. These elements help to reduce the expenses and increase profit through less raw material and energy consumption as well as lower waste disposal charges. Finally, the least crucial advantage of the ISO 14001 implementation by industries in Penang is in improving staff morale and motivation. Awareness and commitment about environmental matters help to enhance the morale of the workforce and encourage employees to be more accountable towards the environment. A highly motivated worker is expected to work together with the management, which will help in developing the manager-worker relationship [39]. Overall, the effectiveness marks show that the companies in Penang obtained the ISO 14001 certification to enhance the company's image, increase business opportunities, and boost the morale and motivation of the workforce, which in turn will improve the consumer loyalty towards the company.

3 Conclusion

AHP provides a multi-attribute estimation technique to help one identify the components and sub-elements necessary for a successful ISO 14001 implementation. This study includes a framework to evaluate and understand the critical success factors and benefits of the ISO14001 implementation. The findings of this study suggest that every employee should be adequately educated, and their awareness of environmental issues should be increased. For the quality improvement of environmental management

to be successful, appropriate equipment must be available within the company to track basic and technical skills. Benefits of the ISO 14001 implementation include enhancing the company's image and credibility, improving the process performance, boosting customer confidence and trust, and improving the morale and partnership between the top management and employees. The ISO 14001 implementation by industries can assist them in improving their environmental performance. This research provides new insights not only to the industries but also to several parties such as practitioners, academics, and policymakers in the management of environmental quality. For future research, the authors will be looking at the relationship between environmental performance and company performance.

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