

Mediating Role of Carbon Accounting Between Carbon Risk Management and Carbon Performance

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Abstract

The literature on carbon management has focused on how businesses might employ carbon innovation to turn environmental challenges and gain competitive advantages. This study advances carbon management awareness among Malaysian firms accredited by the International Organization for Standardization (ISO) 14001. The study specifically aims to evaluate the impact of carbon risk management on carbon performance through the mediating variable of carbon accounting. This study employed a quantitative approach; data on carbon management ISO 14001 accredited enterprises will be analysed using structural equation modelling (SEM). This paper presents a conceptual framework proposed and a fundamental understanding of the relationship between carbon risk management, carbon accounting, and carbon performance in Malaysia. It also hopes to provide information on enterprises' management practices, particularly for ISO 14001-accredited companies and other businesses.

Keywords: Carbon risk management, carbon performance, carbon accounting, ISO 14001

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1. Introduction

Carbon emissions might substantially affect business activities and behaviour (Bebbington & Larrinaga-González, 2008). Therefore, businesses must regulate and minimise CO₂ emissions while significantly integrating climate considerations into their business strategy (Alsaifi et al., 2020). This research focuses on corporate carbon strategies that employ carbon accounting to improve corporate carbon performance. Carbon emission reductions need a compelling business carbon strategy, such as carbon risk management. However, the carbon strategy and carbon accounting system are inextricably linked, making them mutually reliant. According to (Kumarasiri & Jubb, 2016), a carbon accounting system implements a company's carbon strategy to enhance efficiency in reducing carbon emissions and obtain a competitive advantage. Additionally, according to Ong et al. (2021), the strategy's adoption has no direct impact on organisational performance; nevertheless, performance is improved when carbon accounting is used in conjunction with the company's carbon policies to obtain higher business performance.

A comprehensive understanding of the environment's surroundings and effects is required to transition ecologically detrimental traditional practices and behaviours into more environmentally favourable ones (Steininger et al., 2016). Consequently, companies must be mindful of decreasing CO₂ emissions while establishing carbon accounting processes. They must also grasp the elements that influence specific emissions and the necessity for adequate carbon strategies that fulfil their requirements. According to carbon accounting standards, a corporation needs critical internal mechanisms, such as carbon plans, to establish a complete carbon mitigation system. According to (Schaltegger & Csutora, 2012), implementing carbon accounting methods in enterprises is required to support projects or strategic solutions. According to (Bebbington & Larrinaga-González, 2008), only a few approaches exist to accomplish excellent corporate carbon performance and reporting. The initial step is to establish the carbon accounting limits to focus on and which business activities release substantial volumes of CO₂. The second stage is to determine the consumption figures, which is essential since precise measurements and computations of CO₂ emissions rely on reliable energy consumption estimates. As a result, carbon accounting is critical for estimating exact CO₂ emission values. The third step is to develop appropriate carbon strategies based on the organisation's needs. In addition to hard facts and figures about CO₂ emissions, businesses' efforts to reduce CO₂ emissions or protect the environment must be reflected in their corporate strategies (Zhou et al., 2020). Companies must embed carbon strategies into their operation to stay competitive. These strategies include incorporating carbon governance,

identifying and managing carbon risks, and setting carbon reduction targets; these measures help companies to keep track of their efforts to improve carbon performance, always be guided by standard compliances, and encourage the stakeholders' involvement in their mitigation efforts. Consequently, carbon strategy and accounting development have become critical in the current business sphere, especially when processes and systems are interdependent.

More scientists and researchers are considering the association between carbon performance and firm performance in the current development. However, whether carbon disclosures align with an organisation's carbon performance still needs to be solved (Jinru et al., 2022). According to (Bui & de Villiers, 2017), their result implies that participants must be more responsive toward the organisation's carbon performance. Organisations are irresponsible because there is a possibility of insufficient and unreliable carbon information from carbon performance (Tang et al., 2022). Moreover, organisations require more information to be adequate to evaluate companies' performance. Due to insufficient information, poor carbon performance is evident among Malaysian companies. The inadequate carbon information in carbon performance could be due to the absence of a carbon accounting system where a company cannot capture and generate adequate carbon information to present the carbon performance of a company. Hence, Malaysian companies might be reluctant to produce a carbon performance because there is no substantial evidence showing that Malaysian companies' carbon performance can positively impact financial performance. Again, this circumstance reflects companies' need for more awareness of carbon footprint issues.

This study contends that improved carbon performance results from implementing carbon accounting, which is influenced by an organisation's carbon risk management. Hence, this study aims to address the following questions: 1) Does corporate carbon risk management positively influence the implementation of carbon accounting? 2) Does carbon accounting mediate the relationships between corporate carbon risk management and carbon performance? 3) Does implementing carbon accounting positively influence carbon performance?

The first objective of this study is to examine the influence of corporate carbon risk management on implementing carbon accounting. Secondly, this study analyses the mediating effects of carbon accounting in the relationships between corporate carbon risk management and carbon performance. The third objective of this study is to examine the influence of carbon accounting implementation on carbon performance.

2. Literature Review

2.1 Carbon Risk Management

Climate change and carbon emissions are both acknowledged as hazards to businesses. Risk management refers to companies' actions to address and prevent the possibility that a risk will materialise. Thus far, research on corporate adaptation to the physical repercussions of climate change has raised the risk management issue (Alsaifi et al., 2020; Luo & Tang, 2016; Yu et al., 2022). Europe, Australia, New Zealand and a few more countries have already implemented environmental preservation laws to reduce carbon emissions due to the ratification of the Kyoto Protocol. These countries recognised carbon emissions as a posing risk and business opportunities. Therefore, organisations adopt carbon accounting as a business strategy (Bui & de Villiers, 2017; Schaltegger & Csutora, 2012). Risk management includes the identification, measurement, appraisal, and treatment of hazards that have a negative impact on corporate performance (COSO, 2004); (Bui & de Villiers, 2017). From another perspective, risk management can also be a management control system, as it can control employees' behaviour (Pei et al., 2021). Risk management also entails the evaluation of threats and opportunities associated with climate change mitigation (Ong et al., 2021; Yu et al., 2022). The literature acknowledges the relationship between risk management and managerial accounting, but a few studies give empirically based understandings (Ahmed et al., 2012; Ascui, 2014; Kasbun et al., 2016; Kumarasiri & Jubb, 2016). There is scant empirical information about the relationship between regulatory risks and carbon emissions management schemes, their interrelationship with internal organisational risks, and how firms employ management control procedures to handle and minimise these risks (Alsaifi et al., 2020; Bui & de Villiers, 2017; Zhou et al., 2020). Firth et al. (2016) & Steininger et al. (2016) contend that management accounting techniques are essential in climate change risk management. Ngwakwe (2012) emphasises that when a business takes capital investment decisions connected to a carbon emissions reduction plan, it will face significant strategic risks associated with the availability of technology to capture carbon information and carbon price. Due to the usage of fossil fuels to create power, the lack of available technology to reduce a company's carbon emissions will result in technological risk and expense. Market risks are also associated with carbon price fluctuations and changes in firms' capacity to pass carbon-related costs on to consumers (Yu et al., 2022). Correspondingly, Gibassier et al. (2020) assert that the instability of carbon credit market value complicates the measurement of compliance costs and raises the strain on corporate performance and risk management. Even though climate change rules or regulations have been enacted, the occurrence of all of these dangers still has a chance. Besides these risks, an organisation's carbon emission also conveys reputation risk for organisations (CERES, 2007). PwC's (2009) report on the Carbon Disclosure Project (CDP) found that utility and power generator companies have

acknowledged their exposure to the supplementary regulation and public inquiry about emissions, mainly when the media and politicians are involved. Society's increased awareness about carbon emissions reduction has strengthened and enhanced; the societal awareness is manifested in the form of eco-consumerism activities such as choosing low-carbon products and technologies; however, these kinds of movements have also increased reputational risks (Macina et al., 2019; Ong et al., 2021; Zhu et al., 2022).

On the other hand, despite all these possible risks, the circumstance also provides opportunities, especially in the strategic market, such as producing eco-products to capitalise on eco-consumerism (Burritt & Tingey-Holyoak, 2012; Huang & Kung, 2010; Schaltegger & Csutora, 2012). Every risk creates an opportunity, and every opportunity creates a risk. For example, potential compliance costs (all the costs an organisation has to pay to follow industry regulations) or risks associated with high carbon emission organisations. Currently, the opportunity for low-carbon emission companies is that they can offer cheaper goods or services. In addition to the dangers (and opportunities) connected with carbon dioxide emissions, businesses may need regulatory clarity, such as when there is international pressure. At the same time, the government remains mute about its intended policies to cut carbon emissions. This type of uncertainty might inspire firms to take a practical and strategic response because of their inability to forecast both the likelihood and the impact of regulation. When there is a precise regulation of carbon emissions, firms can evaluate the predicted compliance costs from several perspectives, such as shifting carbon prices or the availability of carbon mitigation technology. Based on these assessments, organisations can transmit suitable solutions, such as investing in or supporting eco- or renewable technology (Ascui, 2014; Csutora & Harangozo, 2017; Na et al., 2019; Yeh et al., 2019).

Butterworth (2015) claimed that no research has yet examined how the development and application of management control systems in risk management and CO₂ reduction strategies are impacted by regulatory uncertainty. Some companies view carbon accounting as a way to lower risks, while others see it as enhancing their reputation and image. Therefore, a business needs a strategy to minimise the risks and maximise the benefits of carbon emissions. The top management is known to communicate with interactive control systems more frequently about risk management for carbon emissions and carbon strategy (Csutora & Harangozo, 2017). Ascui (2014) argues that accounting methods can illuminate the dangers and opportunities associated with cutting carbon emissions that could go unnoticed. This is reinforced by survey participants' statements that they still needed to research measures to reduce their carbon footprint before measuring it.

Furthermore, the interview statistics show how accounting information helps firms ensure successful risk management. Furthermore, an effective accounting system implies that the respondents know the risks and opportunities related to their business operations. Managers have recognised the value of utilising management accounting techniques, including

mitigating climate change-related risks (Kumarasiri & Jubb, 2016). By utilising management accounting and the right strategy, organisations should be able to manage shifting risks and exploit chances to achieve their objectives.

2.3 Carbon Performance

The phrase "carbon performance" refers to a company's capacity to lower its carbon footprint in terms of the overall amount released into the atmosphere and the number of emissions created per product or operational unit (Alsaifi et al., 2020). Furthermore, emissions from energy supply or product use should be more generally disclosed in emissions reports, which may conceal the entire level of a company's emissions. Metrics that accurately quantify a company's carbon performance should be developed so that carbon assessments are more trustworthy and organisational performance gaps can be tracked (Huang & Kung, 2010). Furthermore, (Tang et al., 2022) anticipate that improved environmental performance will open new markets, alter costs, and increase performance.

Carbon performance creates more chances by converting negative connections to significant correlations, which results in financial rewards (Ahmed et al., 2012). Nevertheless, the protracted process of policy and legal reforms limits enterprises' ability to improve carbon performance, sending negative signals to climate-conscious corporate players (Benz et al., 2021). As a result, companies need more motivation to enhance their carbon performance by more than a bare minimum. In addition, Lewandowski (2017) claimed that despite increasing governmental pressure to report carbon performance, firms need to be more effective in combating climate change. However, greater carbon performance will unquestionably result in improved financial performance. In response to the increased public interest in carbon performance and demand for carbon-related information, governments have been compelled to issue new carbon-related directives or incorporate carbon-related components into current legislation. However, the public's rising interest in carbon performance and demand for transparency has compelled investors' willingness or ability to use this information to make investment decisions (Burritt & Tingey-Holyoak, 2012; Kasbun et al., 2016; Tang et al., 2022). Firms that engage in sustainability practices or sustainability reports (through carbon accounting) are more likely to observe an increase in their share price, a significant competitive advantage, and ultimately better overall organisational performance.

2. Conceptual Framework and Hypothesis Development

The resource-based view (RBV) is a fundamental paradigm in strategic management because it explains achieving and retaining a long-term competitive advantage or generating exceptional returns for shareholders (Grant, 1991). Such profits can be earned by resource exploitation, such as monopolistic ownership of a competitive heterogeneity (such as the

carbon strategy) or the development of resources that are hard to reproduce (Aragón-Correa & Sharma, 2003).

Carbon risks may originate from either the emitting nature of the industry or the introduction of strict carbon legislation. These are the two primary sources of potential carbon risks. Because of these two factors, additional expenditures associated with the environment were incurred, such as those for risk management, clean-up, or compliance fees. If a firm engages in actions that could be detrimental to the environment, such as releasing large amounts of carbon dioxide into the atmosphere, the company's image could suffer (Backman et al., 2017; Dowbiggin, 2021). Risk management is now a critical component of the organisation's overall MCS. To have a better grasp of risk management and how risks can impact control system components as well as business performance. Assume that business uncertainty plays a significant role in the environment. In such circumstances, there is a higher need to understand how a corporation selects and analyses potential developing risks before responding to them through MCS (Backman et al., 2017; Khanra et al., 2022). As a result, carbon risk management includes assessing carbon emission-related hazards that could put organisations at risk of problems due to their favourable or unfavourable indirect effects on business operations.

In line with these reasons, Sodhi (2015) asserted that accounting methods assist in controlling climate change risks. As a result, a carbon strategy that enables data on carbon risk management to be gathered via a carbon accounting system may improve a company's carbon performance while also reviving the environment for the benefit of the country and society. The following hypothesis was proposed in light of the RBV's theoretical arguments:

H1: Carbon risk management positively influences the implementation of carbon accounting.

This study reveals that carbon accounting or a carbon accounting system (CAS) significantly influences the organisation's carbon performance because of the direct correlation between EMA and environmental performance. Research on the relationship between CAS and carbon performance is limited, particularly in the Malaysian setting. The research by Luo & Tang (2016) is the first one to empirically explore the link between enterprises' CAS and carbon emission reduction. Their results demonstrated a link between CAS and carbon mitigation factors. CAS capabilities that acquire and analyse financial and environmental data for internal management have yet to be noticed. Carbon accounting has been found to affect an organisation's performance positively, and the legitimacy theory confirmed this finding. This theory suggests that a firm's actions should reflect the values and beliefs of the social paradigm in which it operates (Suchman, 1995). Carbon emissions can describe a company's actions (Bui & de Villiers, 2017). Given the importance of carbon accounting for businesses, this topic must be addressed and researched thoroughly. Thus, the second hypothesis is proposed using the legitimacy theory:

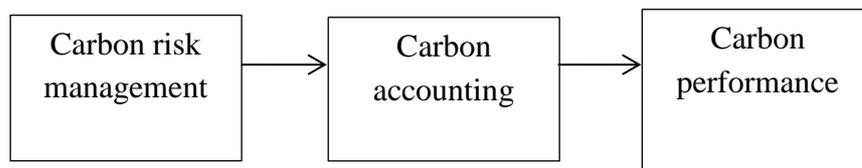
H2: The implementation of carbon accounting positively influences carbon performance.

Businesses now recognise the importance of implementing a robust and agile environmental policy, environment data system, and environmental management control system (EMCS). Like an EMA system, carbon accounting captures and highlights an organisation's carbon information. Several recent studies on EMA attest to the importance of accounting when pursuing environmental management (Aragón-Correa & Sharma, 2003). While the EMCS ensures that resources are used effectively and efficiently to improve environmental performance, applying EMA in an organisation results in an environmental strategy (Pei et al., 2021). Carbon-intensive enterprises are particularly exposed to carbon risk due to their high emission levels (Khanra et al., 2022). The necessity to handle the reputational and financial risks posed by rising energy costs and regulatory reporting requirements prompted the development of carbon accounting and other carbon accounting approaches (Kumarasiri, 2016). According to Csutora & Harangozo (2017), when there is a higher carbon risk present, firms perform poorly, and this effect is more prominent when there is more vital carbon legislation. Hence, a greater knowledge of how businesses react to emerging risks associated with lowering carbon emissions by carbon accounting is essential for carbon performance that enhances the distribution of resources and decision-making. In light of the RBV, the third hypothesis has been put forth:

H3: Carbon accounting mediates the relationship between carbon risk management and carbon performance.

The conceptual framework shown in Figure 1 was developed based on the discussion above.

Figure 1: Conceptual Framework



4. Research Methodology

The study intends to use a cross-sectional survey design to determine the relationship between carbon risk management, carbon accounting and carbon performance. The study will sample all (roughly 600 companies) ISO environmental management system (EMS) accredited enterprises in Malaysia. Companies with ISO 14001 accreditation are proactive in environmental activities, such as incorporating environmental values into their operations and limiting environmental liabilities (Kasbun et al., 2016).

Using structured questionnaires, this study obtains primary data. Additionally, the quantitative research method is used. Descriptive statistics are estimated to find out mean, median and frequency counts. Further, multiple regression will be performed to determine the relationship between dependent and independent variables.

For data collection, a questionnaire is mailed to specific companies and sometimes emailed to them. Cover letters and postage-paid reply envelopes accompany each hardcopy questionnaire form. Phone calls are conducted to detect responses and convince non-responders. Those who had missed the previous questionnaire are provided with a replacement.

The questionnaire has five sections: one for gathering information about the firms and four for measuring the research variables using scales adapted from prior research. Carbon risk management (6 items) is adapted from Damert et al. (2018), Damert et al. (2017), carbon accounting (4 items) was adopted from Csutora & Harangozo (2017), Bahari et al.(2016) and carbon performance (11 items) was adapted from and (Solovida & Latan, 2021). Each item was given a rating from 1 (strongly disagree) to 5 (strongly agree) on a 5-point Likert scale."

5. Result and Discussion

Demographic Profile

Table 1 displays the demographic breakdown of the businesses that participated in this survey. The majority of the businesses (67.7%, $n = 92$) were made up of people in their 20s and 40s. The majority of firms were small and medium-sized, making up 69 per cent of them ($n = 69$). Among the industrial sectors examined, the Other sectors had the highest percentage of respondents ($n = 31$, 22.8%) from the fields of engineering, technology, transportation and automotive, finance, manufacturing, infrastructure, commercial, materials, consulting, operation and maintenance, authority, and government agencies. 94 (69.1%) of the respondent businesses were locally owned, making up the majority.

Table 1: Demographic profile

Description	Frequency	Percentage (%)
n = 136		
Company age		
Below 20 years	20	14.7%
Between 21 to 40 years	92	67.7%
Over 40 years	24	17.6%
Number of employees		
Below 200 (small and medium-sized)	69	50.7%
200 to 500 (large size)	31	22.8%
Over 500 (larger)	36	26.5%
Industrial sector		
Consumer products	20	14.7%
Industrial products	34	25%
Construction	21	15.4%
Trade and services	3	2.2%
Oil and gas	11	8.1%
Plantation	5	3.7%
Mining	2	1.5%
Properties	2	1.5%
Chemicals	3	2.2%
Education	2	1.5%
Healthcare	2	1.5%
Others	31	22.8%

Type of Ownership		
Local	94	69.1%
Foreign	6	4.4%
Joint venture local and foreign	36	26.5%

To demonstrate discriminant validity, the square root of each variable's AVE should be greater than the squared correlations between the variable and other variables (Chin, 1998; Fornell & Larcker, 1981). The diagonal square roots of AVE were larger than the off-diagonal correlations, as indicated in Table 2. Thus, the study model met the criteria for discriminant validity

Table 2: Discriminant Validity

No	Construct	CRM	CA	CP
1	Carbon Risk Management (CRM)	<i>0.839</i>		
2	Carbon Accounting (CA)	0.806	8.828	
3	Carbon Performance (CP)	0.814	0.715	<i>0.805</i>

Note: Diagonals (italic) show the square roots of AVE. The rest are Pearson's correlation values.

Table 3 presents the results of the significance of all the direct paths. Based on the result in Table 3, H1 was supported because of the direct path outcome of carbon risk management and carbon accounting (CRM > CA), which revealed a substantial positive association ($\beta = 0.123$, $p < 0.01$). As expected, when businesses consider regulatory uncertainty a risk to their organisations, they take additional steps to reduce uncertainty-related hazards, such as carbon emissions (Engau & Hoffmann, 2010). It is important to evaluate carbon risk, particularly when that risk's a potential impact on business possibilities. Carbon risk materiality can sometimes be evaluated in regards to financial results, environmental cost intensity, stakeholder consequences, business interruption and unknown risks, deleterious public image, legal issues, and safety and health for the public because it is coherent with the rising interest of risk management in today's business environment. The results of this study indicate that businesses must address carbon risk using carbon accounting as a coping mechanism, depending on the materiality of the risk.

As shown in Table 3, H2 is supported by the direct path result of carbon accounting and carbon performance (CA > CP), which showed that carbon accounting significantly improves carbon performance ($\beta = 0.751$, $p < 0.01$). This result is in line with the claim that determining carbon performance is the main focus of carbon accounting (Hashim et al., 2017). It suggests that better carbon performance results from a company's efforts to incorporate carbon

accounting at the organisational strategic level. The close relationship between carbon accounting and carbon performance shows that improved carbon accounting supports corporate carbon performance, which is essential for satisfying the needs of various stakeholders and fostering transparency for those who want to assess corporate performance and efficiency over the long term.

Table 3: Significance of Direct Paths

Hypothesis	Path	The standard	Standard error ($\sigma\bar{x}$)	t-value	p-value	Result
H1	CRM > CA	0.123	0.043	2.846**	0.004	Significant
H2	CA > CP	0.751	0.054	13.856**	0.000	Significant

Notes: ** significant at $p < 0.01$; CRM is carbon risk management, CA is carbon accounting, and CP is carbon performance.

Table 4 shows that the R^2 values were 0.880 for carbon accounting and 0.850 for carbon performance, which exhibited substantial predictive accuracy.

Table 4: Coefficient of Determination, R^2

Endogenous latent variable	R^2 value	Assessment
Carbon Accounting	0.880	Substantial
Carbon Performance	0.850	Substantial

Table 5 shows the results of the mediation effect. The carbon accounting exhibits a full mediating influence on the relationship between carbon risk management and carbon performance, according to the mediation finding (CRM > CA > CP), which supported H3 ($= 0.092, p 0.01$).

Table 5: Mediation Result

Hypothesis	Path	Standard beta (β)	The standard error ($\sigma\bar{x}$)	t-value	p-value	Result
H3	CRM > CA > CP	0.092	0.034	2.686**	0.007	Significant

Notes: ** significant at $p < 0.01$; CRM is carbon risk management, CA is carbon accounting, and CP is carbon performance.

7. Limitations and Future Research

One of the study's shortcomings is the use of self-reported data from a single informant from each organisation to quantify research variables such as carbon risk management, carbon accounting, and carbon performance. This method has been challenged for potential bias. Given the potential for common method variance in this study, it is advised that future research analyse carbon variables by sampling employees and managers at various levels. The current research, on the other hand, focused solely on the mediating impacts of carbon accounting on carbon performance. Future research may examine the moderating effects of other aspects, including system thinking, open and experimental environments, and management commitment, to add to this body of knowledge. Finally, this study was constrained by its narrow ISO 14001 companies sample and its environment of only one developing nation. In subsequent studies, the experience and application of carbon factors in established and emerging countries could be examined. Hence, more generalizable findings in various contexts should be sought in future research.

8. Conclusion

The findings suggest that carbon risk management is crucial for adopting carbon accounting. Similarly, a strong positive correlation exists between carbon accounting and carbon performance. Carbon accounting also entirely mediated the connection between carbon risk management and carbon performance. This indicates that carbon accounting facilitates the operational function of carbon risk management in enhancing carbon performance. Carbon risk management encourages using carbon accounting, so businesses should strategically build carbon management into their business processes. This makes businesses better at cutting carbon when methods are considered. This study gives proof and basic information about carbon accounting in Malaysia, which is backed up by the results. It also explains how businesses run, especially ISO 14001-accredited companies and other EMS groups.

Thousands of businesses are participating in coalitions and initiatives to monitor and alter their operations to be less carbon-intensive. Companies slowly seek methods of earning more money without hurting the environment, and this helps them be both profitable and sustainable in the long run. Without quick, radical steps to cut carbon and emissions of greenhouse gases, the temperature increase will keep going up, putting millions of people at risk of drought and extreme poverty. Each portion degree the temperature increases will make these problems even more severe. Scholars and activists constantly strive to provide comprehensive answers to the challenges linked with climate change, notably carbon emissions, and to urge international leaders to find a feasible solution. It is hoped that the delay will no longer cause delays in the activities. Although making enough proactive efforts

to cut carbon emissions will be difficult for businesses, particularly in Malaysia, the decisions made today will determine this era in the eyes of future generations. Thus, overcoming the challenge will ensure a new, essentially thriving economy with immense future possibilities.

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