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Industrial Sectors' Perceptions about the Benefits of Implementing ISO 14001 Standard: MANOVA and Discriminant Analysis Approach

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Abstract: The most frequent drawback of ISO 14001 observed in existing studies relates to the cost of certification and implementation process. This drawback requires scaling the benefits of adopting the standard to assign organizations limited resources based on each benefit scale. This paper reports the first research results that scale the benefits of adopting the standard. A quantitative method was adopted, where data were collected using a questionnaire survey. A total of 120 respondents were recruited from organizations operating in six industrial sectors to take part in the study. MANOVA and discriminant analysis methodologies were used to analyze the 14 most cited benefits in the literature on adopting the standard. A novel feature of our approach is the comprehensive statistical analysis of the collected data, which yields robust results due to assumption satisfaction. The results demonstrated that the mean vector of the benefits was not equal per each sector. Environmental management and indicator dimensions can discriminate sectors more than the environmental awareness dimension. This study provides insights into the necessity of assessing the benefits of ISO 14001 adaptation that helps organizations allocate their limited resources optimally and support the listing of standard key performance indicators in ISO 14001. In addition, it calls for combining ISO 9001:2015, ISO 14001:2015, and ISO 45001:2018 in one standard.

Keywords: environmental management systems; ISO 14001:2015; MANOVA; discriminant analysis



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1. Introduction

The United Nations (UN) professed 2021 to be the commencement of the UN Decade on Ecosystem Restoration on 1 March 2019, to promote and enhance efforts to avert, stop, and reverse environmental deterioration and increase awareness of the necessity of effective ecosystem restoration. A total of 348,473 organizations in 195 countries globally have certified their Environmental Management Systems (EMSs) as proof of their environmental commitment [1]. ISO 14001 EMS is centered on and driven by environmental impacts, supports the integration of environmental management and business operations, allows for continuous development, and is verifiable through regular auditing. A number of studies have demonstrated the advantages that firms may achieve by adopting ISO 14001; most of them categorize the benefits as environmental management (EM), environmental indicators (EIs), and environmental awareness and social aspects (EA) [2,3]. Unfortunately, ISO 14001 literature does not agree on the effect of adopting the standard on the environment [4]. Furthermore, few research works have investigated the drawbacks of implementing the standard and showed that the cost of adopting ISO 14001 could be high [5]. Hence, a considerable research area of interest arises concerning the scaling of the benefits of implementing the standard to optimize the assignment of the organizations' limited resources.

The purpose of this paper was to investigate whether the mean vectors representing the benefits from implementing the standard are equal or not among six industrial sectors, in addition to defining the discriminating benefits that may differ from one sector to another.

While some researchers view a positive relationship between adopting ISO 14001 and business EIs, others argue that there is no effect between ISO 14001 certification and some EIs [4]. Regarding the EM dimension, it includes four benefits, rigor and effectiveness of practices (EM01), regulatory compliance (EM02), greener supply chain (EM03), and documentation control (EM04) [3]. Higher rigor for EM01 is generally associated with the implementation of purported best environmental practices, improved employee commitment, and improved management system follow-up through frequent audits [6,7]. All studies on EM02 have demonstrated positive effects, such as increased compliance with environmental regulations and the avoidance of fines for noncompliance [8–10]. In studies that examined this element, enhancements in the greening of supply chain management (EM03) were also identified [11–13]. Other researchers have established that ISO 14001 positively impacts the documenting of environmental practices (EM04), particularly in terms of environmental control [14]. Nonetheless, several investigations showed that the reported improvements were dubious, or the purpose of documenting ISO was frequently misinterpreted within organizations [13,15].

Concerning the environmental performance indicators dimension, it includes six benefits such as reduction and management of waste (EI01), air pollution (EI02), general environmental performance (EI03), consumption of energy and resources (EI04), issues related to environmental risks and safety (EI05), and water contamination (EI06) [3]. Researchers have established that adopting ISO 14001 has a favorable effect on the general reduction and management of waste (EI01) [15–17]. Conversely, some scholars established that the standard has no substantial influence on this issue [18,19]. According to the studies [17,18,20], the use of ISO 14001 reduces pollution of air as well as atmospheric emissions (EI02). Contrary, other research found this relationship to be insignificant [19,21,22]. Furthermore, the findings show somewhat mixed results concerning the EIs dimension: Some scholars established that ISO 14001 positively impacts general environmental performance (EI03) [6,10,23], while other studies found insignificant improvements related to the standard [7,11,19]. Concerning (IE04) some researchers established that using ISO 14001 improved the effectiveness of consumption of energy and resources [15–17], while two papers by Zobel [19,24] found that noncertified organizations performed better in this area. The decline of environmental risk and safety issues (EI05) were discussed in some studies [15,25,26]. Except for Mohammed [27], all these studies established improvements related to the standard. Except [27,28], scholars that have examined how the standard influences water contamination (EI06) [18,19,21] have found insignificant improvements associated with the implementation of ISO 14001.

The social effect of ISO 14001, especially the development of environmental awareness, was discussed in the literature. According to the literature reviewed, the most common benefits of implementing ISO 14001 relate to the effect on organizational image, reputation, and stakeholder relationships (EA01). Apart from [29], all other studies that were reviewed indicated a positive effect of ISO 14001 implementation [15–17,30,31]. According to [26,32], reputation and image improvements are the most significant benefits observed. The effect of ISO 14001 implementation on employee commitment and environmental awareness (EA02) observed improvements [33,34]. Several studies have also found benefits in environmental awareness, communication, and workplace culture [12,29]. However, some studies found no significant improvements in employee commitment and awareness following the implementation of ISO 14001 [35,36]. In relation to the employee competencies and training related to the environment (EA03), some scholars [35,37] established positive effects of ISO 14001 implementation or observed notable actions. However, Concepción López-Fernández and Serrano-Bedia [14] found insignificant change in this area. Some researchers also found that implementing ISO 14001 improves managers' involvement and

support (EA04) [8,29]. These findings were inconsistent with those of [35], who found that ISO 14001 implementation has an insignificant relationship with managers' commitment.

Research on the effect of adopting ISO 14001 on businesses has mostly been restricted to assessing if there is a positive/no significant impact on business environmental performance without comparing the effect of implementing the standard on the various business sectors, which distinguishes our study. This study aimed to explore the association between ISO 14001 implementation and environmental performance among different industrial sectors. This paper sought to show no difference among sectors on the benefits scale based on the views and opinions of environmental department managers and to test if there are any discriminant functions for defining promising discriminant benefits. Thus, the following research questions were formulated: *"Is there a statistically significant difference at 0.05 level of significance between mean vectors of ISO 14001 benefits evaluated based upon the perceptions of environmental department managers due to the difference in the industrial sector or not?"*; and *"Is there is a discriminant effect for benefits of ISO 14001 per sector or not."* We assumed that participants would answer honestly and have a high level of perception about ISO 14001 and environmental management, responses were taken to protect the confidentiality of the information provided by the respondents, involvement in the research was free and voluntary, and respondents would withdraw from the study at any time without any ramifications. For each response, the 14 benefit variables were independent for an organization. In general, 14 benefits of ISO 14001 were focused on in a literature review. Furthermore, the study had three delimitations that restricted the findings. First, the study was delimited to six industrial sectors as the target population in Saudi Arabia (SA). The results may or may not be generally applicable to other sectors or geographic regions. The main reason for choosing these sectors is the largest number of ISO 14001 certified Saudi organizations belong to these sectors [1]. Secondly, the study delimited itself to using a convenience sample from a target population of 255 organizations. All population was contacted and included in the study. Lastly, the study used data collected data from employees working in EM high leadership positions within the organization to minimize the delimitation of the employees.

This study tested whether the mean vector of 14 benefits of adopting ISO 14001 was equal in importance as evaluated by environmental managers in Saudi Arabia by using MANOVA. Furthermore, the discriminant analysis technique was used to define the discriminating benefits per sector. The remaining parts of this research paper are organized as follows: Section 2 outlines the methodological stance adopted to test the benefits of the mean vectors' equivalence and define the discriminating ones; Section 3 presents the results of MANOVA and discriminant analysis methodologies. Section 4 presents the discussion of the study findings in relation to the existing literature. Lastly, Section 5 covers the conclusions drawn from the study and practical applications of the study findings. It also presents the study limitations and recommendations for future research. Moreover, the paper includes an Appendix A.

2. Methods

Since our topic has not been well-researched in the Arab Gulf countries, we adopted the quantitative design to investigate the difference in 6 sectors' perceptions of the benefits of implementing ISO 14001 [38]. The latest results of the International Organization for Standardization (ISO) Survey are for 2020, which showed an approximation of the total number of valid certificates as of 31 December 2020. In Saudi Arabia, there were 515 certifications for 718 sites [1]. Organizations working in 6 economic activities out of 35 were included in the study due to a large number of ISO 14001 certified organizations belonging to these 6 activities compared with the other 29 activities. These activities were; G1: Chemicals, chemical products, and fibers, G2: Plastic and rubber products, G3: Fabricated metal and basic metal products, G4: Construction, G5: Wholesale and retail trade, repairs of motorcycles, motor vehicles, and household and personal goods, and G6: Engineering services. The economic activities were listed on the Saudi national grouping of economic activities based

on the International Standard Industrial Classification (ISIC) of all economic activities [39]. Organization sizes included in the study ranged from low, medium, and large. Minimum 2 years of certification were adopted as inclusion criteria for the participating organizations in the study. These inclusion criteria satisfied that organizations were able to return to their records and judge the questions of the study. The minimum requirements for participants' age, years of experience, and position were 35 years, 2 years, and a manager for the environmental department, respectively. A minimum bachelor's degree is a requirement to participate in the survey. Each organization would be presented if 4 participants working in EM and related departments were shared in the survey. The representative scale of an organization will be the average for the 4 responses.

Non-random sampling is one of the techniques for selecting samples that is based on the research's subjective judgment [40]. Due to the varying company sizes, the data were collected from four employees among top management who are related to ISO 14001. This is because they are central in management and ISO 14001 certification and know the most about environmental management. The interview questions were sent to all interviewers in advance. The main language that was used during interview sessions was Arabic and English. A hundred and fifty organizations approached and participated in the study out of 255 organizations representing approximately 58.82% of the population. A comprehensive research proposal was sent by fax to organizations clarifying the study objectives and expected outcomes in addition to the requirements for valid participation in the survey. Organizations and authors decide together the interview members and sessions dates. The interviews were conducted at the organization's sites from April to December 2020. The face-to-face interviews were conducted with the CEO, President, Vice President, and Manager for each organization for 20 to 30 min.

The sessions took place at the participant's office. The study was approved by our University Internal Review Board to ensure compliance with the University Declaration of King Khalid University. Participants signed a consent to participate in research form indicating the freedom to withdraw at any time, refuse to answer any questions, confidential use of collected data, no direct benefit from participation, agreement for audio-recording for the interview, anonymous identity, retaining the original data with authors, access to collected data at any time, and freedom to contact any participant. Using Pillai's V, the number of groups and the number of variables are equal to 0.4, 6, and 14, respectively, the effect size $f^2(V)$ value based on Muller and Peterson algorithm is equal to 0.086, leading to a total sample size of 108 achieving an actual $f^2(V)$ of 0.832 [41]. Thus, the minimum number of intended observations per group equals 18. A sample of 120 observations was included in the study to achieve reliable $f^2(V)$ with 20 observations per group.

A literature survey revealed that the benefits most often mentioned may be grouped into three broad categories, which are summarized and reviewed in the introduction section as depicted in Table 1. A questionnaire composed of the items in Table 1 was used to measure the benefit of implementing ISO 14001:2015 in organizations. The questionnaire consists of 14 Likert scale importance values represented for each benefit. The participants indicated their evaluation of the level of importance for each benefit on a 9-point scale, which ranged from "extremely unimportant" to "extremely important". The questionnaire was depicted in Appendix A. Interviews were conducted with four representatives per organization by the research team; collecting information in e-documents and EMS annual reports and comparing interview results with retrieved data could increase the construct validity and improve the accuracy of the study's findings and conclusions [42]. To increase the internal validity of this study, we compared the data collected from interviews between researchers and between recorded notes [43]. The generalizability of the research's findings corresponds to the external validity quality of the research [44]. In this study, the external validity can be generalized to Saudi Arabia's concerning 6 sectors, but it has a limited generalization ability to the global organizations working in the same activities due to the difference in culture, a type developed or developing countries, or even organization size. In this study, an audio recorder and note-taking are used during the interview to

increase the study reliability of data collection [45]. The interview questions were sent to interviewees in advance to allow them to know the interview's approach. On top of that, we do respect the interviewees if they do not feel free to answer some questions. The interviewees were carefully chosen based on the related responsibility to ISO 14001, ensuring that job positioning and personal relationships are not factors when choosing interviewees.

Table 1. Summary of benefits of obtaining ISO 14000 certification documented in the literature.

Category (Code)	Dependent Variable Title (code)	References	
		Positive Impact	No Significant Impact
EM	Rigour and effectiveness of practices (EM01)	[7,8,34]	–
	Regulatory compliance (EM02)	[9–11]	–
	Greener supply chain (EM03)	[12,13]	–
	Documentation control (EM04)	[15]	[13,14]
	Waste minimization and management (EI01)	[16,17,20]	[18,21]
EI	Air pollution (EI02)	[20–22]	[18,23,24]
	Environmental performance in general (EI03)	[7,11,25]	[8,12,18]
	Energy and resources consumption (EI04)	[16,17,20]	[18,19]
	Environmental risks and safety issues (EI05)	[13,16,26,27]	[28]
	Water contamination (EI06)	[28,29]	[18,22,23]
EA	Image and stakeholders (EA01)	[16,17,20,31,32]	–
	Employee's involvement (EA02)	[34,35]	[36,37]
	Employee's training and knowledge (EA03)	[36,38]	[15]
	Manager involvement (EA04)	[9,30]	–

A MANOVA was undertaken to examine if there exists a notable difference in the linear combination of the fourteen ISO 14001' benefits between the levels of group sectors. Before conducting the MANOVA, collected data were checked to ensure that there was a moderate correlation between dependent variables, multivariate normality, absence of multicollinearity, and the homogeneity of the covariance matrices [46]. Pearson correlation was utilized to evaluate the moderate correlation range between 0.3 and 0.7 [46], and multivariate normality was tested by Henze–Zirkler's test developed by Henze and Zirkler as cited in [47]. There exists no known uniformly strongest test; thus, it is recommended that different tests be performed to evaluate multivariate normality. The Henze and Zirkler test has been shown to have good overall strength over alternatives to normality. This test has desirable characteristics such as affine invariance, symptotic power against contiguous alternatives of order $n^{-1/2}$, consistency against any fixed non-normal alternative distribution, and any dimension's and sample size's feasibility. The absence of multicollinearity was tested against a Variance inflation factor (VIF) value to be less than 5 [48]. Box's M test was utilized to test the homogeneity of covariance matrices [49]. Statistical tests were based on the level of significance $\alpha = 0.05$. The relationship between the standard benefits and economic activity level was further analyzed using ANOVA.

3. Results

MANOVA was undertaken to examine if there exists a notable difference in the linear combination of EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04 between six Saudi industrial sectors. Furthermore, discriminant analysis was utilized to define the variables that have a significant discrimination effect on the sector type. In the following, we will discuss how these results might be important for shedding light on the development of the international standard ISO 14001. A minimal data set can be accessed on the Figshare website [50].

(a) Descriptive statistics

Summary statistics were calculated for EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04. Table 2 includes the descriptive statistics for

the dependent variables disaggregated by the independent variables for a sample of 120 and a group size of 20.

Table 2. Mean and standard deviation for EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04 by sector.

Sector Statistic DV	G1 (n = 20)		G2 (n = 20)		G3 (n = 20)		G4 (n = 20)		G5 (n = 20)		G6 (n = 20)		Total (n = 120)	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
EM01	7.750	0.416	80.183	0.613	8.229	0.492	7.733	0.488	8.246	0.504	7.733	0.518	7.979	0.553
EM02	4.587	0.561	40.643	0.479	40.678	0.452	4.538	0.605	40.651	0.573	40.499	0.528	4.599	0.528
EM03	50.324	0.503	5.267	0.537	5.767	0.439	5.292	0.478	5.826	0.487	50.308	0.522	50.464	0.540
EM04	6.295	0.483	5.943	0.567	6.527	0.512	60.027	0.604	6.531	0.510	6.212	0.443	6.256	0.559
EI01	1.266	0.533	1.275	0.505	10.162	0.501	1.211	0.578	10.377	0.628	1.217	0.391	1.251	0.521
EI02	7.220	0.533	70.344	0.611	70.184	0.562	70.176	0.514	7.288	0.580	7.255	0.598	7.245	0.558
EI03	2.915	0.505	3.271	0.439	20.678	0.362	20.680	0.484	3.283	0.506	30.082	0.490	2.985	0.521
EI04	20.424	0.610	20.465	0.565	1.951	0.538	1.992	0.564	2.513	0.395	20.409	0.508	2.292	0.571
EI05	6.836	0.487	6.859	0.502	60.645	0.379	60.663	0.478	70.079	0.394	60.652	0.484	6.789	0.474
EI06	20.063	0.474	1.963	0.523	10.464	0.572	10.452	0.578	20.028	0.553	10.458	0.443	1.738	0.588
EA01	50.694	0.520	50.647	0.535	50.632	0.614	5.221	0.448	5.542	0.565	50.638	0.612	5.562	0.563
EA02	3.773	0.570	3.725	0.529	3.746	0.542	30.690	0.481	30.639	0.499	3.719	0.526	3.715	0.516
EA03	8.218	0.392	80.166	0.407	80.187	0.375	80.185	0.438	80.195	0.325	8.243	0.470	80.199	0.396
EA04	40.111	0.525	40.062	0.500	40.145	0.554	30.652	0.448	3.837	0.462	40.104	0.569	3.985	0.532

(b) Sample profile

The profile of respondents: 100% of the participants were males because of the societal nature of the working environment in SA. Descriptive statistics for the age of the 120 respondents reveal an overall mean score of 47.53 years (SD = 50.64). This shows that the sample age is concentrated near the center point of the interval, ranging from 35 to 60 years, indicating some homogeneity type. These results are due to most of the sample ages being located in the interval of 46–50 years with a percentage of 44.017. The overall average of respondents' years of experience was 90.45 years (SD = 3.91). This indicates that the respondents have sufficient experience to judge the questionnaire's questions and the questions they answered, which is reinforced by the fact that most of them (480.33%) work in CEO positions.

Profile of responses by subsector, firm size, year of ISO 14001 certification: The number of respondents in the population representing the economic subsectors of fibers, chemicals, and chemical products, plastic and rubber products, fabricated metal and basic metal products, construction, retail and wholesale trade, repairs of motorcycles, motor vehicles and household and personal goods, and engineering services of 20, 23, 27, 28, 25, and 27 from populations of 20, 23, 61, 77, 30, and 44 respectively. A total of 150 organizations participated in the survey, of which 130.33% were chemicals, chemical products, and fibers organizations, 150.33% were rubber and plastic products organizations, 180.00% were basic metal and fabricated metal products organizations, 180.67% were construction organizations, 160.67% were wholesale and retail trade, repairs of motorcycles, motor vehicles and household and personal goods organizations, and 180.00% representing engineering services organizations. A total of 440.67% of organizations were large enterprises, 250.33% were medium-sized, while 300.00% of the organizations were small size. All certified organizations [18] working in the chemicals, chemical products, and fibers sector responded to the questionnaire 10 of 20 organizations certified or renewed certification after 2009, 3 organizations in the period of 2008–2009, 4 organizations in the period of 2006–2007, and 3 organizations are certified in 2006. It is noticeable that 50% of organizations were certified after 2009. The sample covered a variety of respondents concerning age, years of experience, respondent position, six industrial sectors, firm size, and year of certification, which reflects that the most sample opinions were built on the environmental respondents' perceptions which gives confidence in the result of the analysis. Out of 150 responses, 30 responses were excluded from analysis due to the existence of outliers.

(c) MANOVA results

MANOVA assumptions check: For one-way MANOVA, preliminary assumptions testing was conducted. Interval/ratio level-dependent variables: The organizations' responses were summarized as the average of four responses from managers who work in managing the EMS satisfying the continuous dependent variables condition. Unrelated categorical independent variable: The economic activity that organizations belong to includes six groups (fibers, chemical, and chemical products, plastic and rubber products, fabricated metal and basic metal products, construction, retail, and wholesale trade, repairs of motorcycles, motor vehicles and household and personal goods, and Engineering services).

Independence of observations: There exists no significant relationship between the observations within every group or between the groups themselves. Data collection was performed to guarantee that different research subjects were in every group, with no research subject being in more than one group. Adequate sample size: Utilizing Pillai's V , the number of groups, and the number of variables equivalent to 0.4, 6, and 14, respectively, the effect size $f^2(V)$ value based on Muller and Peterson algorithm is equaled to 0.086, leading to a total sample size of 108 accomplishing an actual $f^2(V)$ of 0.832 [41]. Thus, the minimum number of intended observations per group equals 18. A sample of 120 non-outlier perceptions was included in the study to achieve reliable $f^2(V)$ with 20 perceptions per group.

Absence of univariate or multivariate outliers: Outliers per group were identified if a point's value was more than three standard deviations from the group's mean. Outlier points per group were removed from the dataset before performing MANOVA. Multivariate outliers were detected based on the Wilks method developed in 1963 for detecting a single outlier from a normal multivariate sample and approaching the maximum squared Mahalanobis distance to an F distribution function by the Yang and Lee 1987 formulation. There are no outliers in the validated sample data set used in the analysis. Multivariate normality: Henze–Zirkler's test [47] was used to test the multivariate normality. Results indicated that the Henze–Zirkler statistic = 0.998, associated p -value = 0.084, hence, data are multivariate normal ($p = 0.05$). Linear relationship of dependent variables: The R function `ggpairs()` [GGally package] lists the Pearson product correlation (r) among ISO 14001 benefits. The values of r_s represent the pairwise relationship between the outcome variables for each group and indicate a significant linear relationship for EMs variables at $p = 0.01, 0.05$, or 0.001 .

Homogeneity of variance-covariance matrices: Box's M test of equality of covariance was performed to examine the homogeneity of variance-covariance matrices across sector levels. The results were significant based on $\alpha = 0.05$. Box's $M = 631.264$, $F = 0.814$, $df1 = 525$, $df2 = 19212.882$, and $p = 0.999$, that is greater than 0.05 indicating that the covariance matrices for each sector level were significantly not different from one another and that the assumption was met.

Absence of multicollinearity: Calculating the linear regression model of EM01 as dependent variable and other benefits as independent variables ($EM01 \sim \text{constant} + EM02 + EM03 + EM04 + EI01 + EI02 + EI03 + EI04 + EI05 + EI06 + EA01 + EA02 + EA03 + EA04$) results in collinearity statistics in terms of tolerances and VIFs for independent variables. The maximum calculated VIF equals 2.985, which is less than 5, and the minimum tolerance equals 0.335, which is greater than 0.1, indicating that there is no multicollinearity among outcome variables. The correlation coefficients of dependent variables range from 0.3 to 0.7, indicating a moderate correlation and that there is no singularity among dependent variables as depicted in Table 3, which provides a Pearson correlation coefficients matrix among variables. Univariate normality assumption: The Shapiro–Wilk test function `shapiro_test()` in the R package “rstatix” was used to assess normality for multiple variables by groups. Results indicated that variables are normally distributed for each sector group ($p > 0.05$). However, the MANOVA is practically strong to modest defilements of normality when the same size is at least 20 in each cell [51].

Table 3. Pearson correlation matrix.

INDVs	EM01	EM02	EM03	EM04	EI01	EI02	EI03	EI04	EI05	EI06	EA01	EA02	EA03	EA04
EM01	1	0.633 **	0.695 **	0.634 **	0.387 **	0.410 **	0.429 **	0.402 **	0.413 **	0.416 **	0.438 **	0.412 **	0.398 **	0.399 **
EM02	0.633 **	1	0.683 **	0.665 **	0.444 **	0.422 **	0.389 **	0.425 **	0.412 **	0.394 **	0.392 **	0.428 **	0.421 **	0.417 **
EM03	0.695 **	0.683 **	1	0.687 **	0.420 **	0.376 **	0.383 **	0.363 **	0.437 **	0.398 **	0.358 **	0.394 **	0.398 **	0.375 **
EM04	0.634 **	0.665 **	0.687 **	1	0.428 **	0.412 **	0.376 **	0.425 **	0.433 **	0.412 **	0.400 **	0.386 **	0.426 **	0.412 **
EI01	0.387 **	0.444 **	0.420 **	0.428 **	1	0.632 **	0.645 **	0.644 **	0.674 **	0.673 **	0.406 **	0.423 **	0.436 **	0.434 **
EI02	0.410 **	0.422 **	0.376 **	0.412 **	0.632 **	1	0.660 **	0.655 **	0.669 **	0.615 **	0.427 **	0.446 **	0.425 **	0.357 **
EI03	0.429 **	0.389 **	0.383 **	0.376 **	0.645 **	0.660 **	1	.728 **	.723 **	0.642 **	0.398 **	0.420 **	0.412 **	0.439 **
EI04	0.402 **	0.425 **	0.363 **	0.425 **	0.644 **	0.655 **	.728 **	1	0.678 **	0.699 **	0.420 **	0.416 **	0.411 **	0.389 **
EI05	0.413 **	0.412 **	0.437 **	0.433 **	0.674 **	0.669 **	.723 **	0.678 **	1	0.695 **	0.392 **	0.417 **	0.405 **	0.374 **
EI06	0.416 **	0.394 **	0.398 **	0.412 **	0.673 **	0.615 **	0.642 **	0.699 **	0.695 **	1	0.452 **	0.424 **	0.380 **	0.403 **
EA01	0.438 **	0.392 **	0.358 **	0.400 **	0.406 **	0.427 **	0.398 **	0.420 **	0.392 **	0.452 **	1	0.626 **	0.666 **	0.684 **
EA02	0.412 **	0.428 **	0.394 **	0.386 **	0.423 **	0.446 **	0.420 **	0.416 **	0.417 **	0.424 **	0.626 **	1	0.680 **	0.666 **
EA03	0.398 **	0.421 **	0.398 **	0.426 **	0.436 **	0.425 **	0.412 **	0.411 **	0.405 **	0.380 **	0.666 **	0.680 **	1	0.643 **
EA04	0.399 **	0.417 **	0.375 **	0.412 **	0.434 **	0.357 **	0.439 **	0.389 **	0.374 **	0.403 **	0.684 **	0.666 **	0.643 **	1

** Correlation is significant at the 0.01 level (2-tailed).

MANOVA' results: The main effect for industrial sector was significant, Wilks' $\Lambda = 0.102$, $F(70, 484) = 4.265$, $p < 0.001$, partial $\eta^2 = 0.367$, and observed power = 10.00, suggesting the linear combination of ISO 14001 benefit variables (EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04) was significantly different among the levels of industrial sector. Furthermore, the effect size is large. The observed power was 10.00, which indicates that there was a 100% likelihood that the findings could be significant. The MANOVA results are shown in Table 4.

Table 4. MANOVA results for ISO 14001 benefits by the industrial sector.

Effect	Wilks' Lambda	F	Hypothesis df	Error df	p	Partial η^2	Noncent. Parameter	Observed Power
Sector	0.102	4.265	70.000	484.944	0.000	0.367	280.790	1.000

To further examine the effects of sectors on EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04, an Analysis of Variance (ANOVA) was performed for each dependent variable to assess if there were significant differences in ISO 14001 benefits by sectors (Table 5). Using the Bonferroni method based on an $\alpha = 0.003$ (0.05/14), ANOVAs were significant and indicated that there were significant differences in EM01, EM03, EM04, EI03, EI04, and EI06 among the sector levels. Considering EM variables, initially, EM01 has $F(5, 114) = 50.402$, $p = 0.000$, indicating that there were significant differences in EM01 among sector' levels. The Partial η^2 was 0.192, indicating the sector explains approximately 19.2% of the variance in EM01. Secondly, EM02 has $F(5, 114) = 0.345$, $p = 0.884$, which indicated that there were insignificant differences in EM02 among sector' levels. The Partial η^2 was 0.015, indicating the sector explains approximately 1.5% of the variance in EM02. Thirdly, EM03 has $F(5, 114) = 50.469$, $p = 0.000$, indicating that there were significant differences in EM03 among sector' levels. The Partial η^2 was 0.193, indicating the sector explains approximately 19.3% of the variance in EM03. Last EM04 has $F(5, 114) = 40.445$, $p = 0.001$, which revealed that there were significant differences in EM04 among sector' levels. The Partial η^2 was 0.163 indicating the sector explains approximately 16.3% of the variance in EM04.

Concerning the EI variables, Initially, EI01 has $F(5, 114) = 0.391$, $p = 0.854$, implying that there were insignificant differences in EI01 among sector' levels. The Partial η^2 was 0.017, which indicated that the sector explains approximately 1.7% of the variance in EI01. Secondly, EI02 has $F(5, 114) = 0.259$, $p = 0.934$, indicating that there were no significant differences in EI02 among sector' levels. The Partial η^2 was 0.011, indicating the sector explains approximately 1.1% of the variance in EI02. Thirdly, EI03 has $F(5, 114) = 6.813$, $p = 0.000$, indicating that there were significant differences in EI03 among sector levels. The Partial η^2 was 0.230, indicating the sector explains approximately 23.0% of the variance in EI03. Fourthly, EI04 has $F(5, 114) = 40.433$, $p = 0.001$, indicating that there were significant differences in EI04 among sector levels. The Partial η^2 was 0.163, implying that the sector explains approximately 16.3% of the variance in EI04. Fifthly, EI05 has $F(5, 114) = 2.806$,

$p = 0.020$, which indicated that there were insignificant differences in EI05 among sector levels. The Partial η^2 was 0.110, indicating the sector explains approximately 11.0% of the variance in EI05. Last, EI06 has $F(5, 114) = 6.875$, $p = 0.000$, indicating that there were significant differences in EI06 among sector levels. The Partial η^2 was 0.232, indicating the sector explains approximately 23.2% of the variance in EI06.

Regarding EA variables, Firstly, EA01 has $F(5, 114) = 1.997$, $p = 0.084$, which indicated that there were insignificant differences in EA01 among sector levels. The Partial η^2 was 0.081, indicating the sector explains approximately 8.1% of the variance in EA01. Secondly, EA02 has $F(5, 114) = 0.156$, $p = 0.978$, implying that there were insignificant differences in EA02 among sector levels. The Partial η^2 was 0.007, indicating the sector explains approximately 0.7% of the variance in EA02. Thirdly, EA03 has $F(5, 114) = 0.092$, $p = 0.993$, indicating that there were no significant differences in EA03 among sector levels. The Partial η^2 was 0.004, indicating the sector explains approximately 0.4% of the variance in EA03. Last, EA04 has $F(5, 114) = 2.976$, $p = 0.015$, which meant that there were insignificant differences in EA04 among sector levels. The Partial η^2 was 0.115, indicating that the sector explains approximately 11.5% of the variance in EA04.

Table 5. ANOVA table for EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04 by sectors.

Variable	SS	df	F	<i>p</i>	Partial η^2	Observed Power
EM01	6.977	5	5.402	0.000	0.192	0.987
EM02	0.495	5	0.345	0.884	0.015	0.135
EM03	6.708	5	5.469	0.000	0.193	0.988
EM04	6.062	5	4.445	0.001	0.163	0.963
EI01	0.545	5	0.391	0.854	0.017	0.149
EI02	0.417	5	0.259	0.934	0.011	0.112
EI03	7.441	5	6.813	0.000	0.230	0.998
EI04	6.327	5	4.433	0.001	0.163	0.963
EI05	2.926	5	2.806	0.020	0.110	0.819
EI06	9.518	5	6.875	0.000	0.232	0.998
EA01	3.043	5	1.997	0.084	0.081	0.652
EA02	0.215	5	0.156	0.978	0.007	0.085
EA03	0.075	5	0.092	0.993	0.004	0.070
EA04	3.893	5	2.976	0.015	0.115	0.844

Table 6 shows the Bonferroni multiple comparisons in relation to the observed means. The means difference is significant at the $\alpha = 0.05$ for all comparisons in the table. For example, the benefit variable EI06 located in the cell corresponding to G1 and G3 implies that there exists a significant difference in the mean of the variable between G1 and G3 equal to 0.599 for G1. The means for variables EM01, EM03, EM04, EI03, EI04, and EI06 between G4 and G5 are equal to -0.512 , -0.535 , -0.504 , -0.603 , -0.522 , and -0.576 , respectively. Furthermore, it is noticed that the industrial sectors pairs of (G1, G2), (G3, G6), and (G4, G6) do not contain any variables, whereas sector pairs of (G1, G3), (G1, G4), and (G1, G6) includes one variable. Sector pairs of (G1, G5) and (G2, G6) include two variables. Sector pairs of (G2, G4), (G3, G4), and (G5, G6) include three variables. Sector pairs of (G2, G3) and (G3, G5) include five variables, while the pair of (G4, G5) includes six variables. All Gs pairwise comparisons were significantly different for each of the outcome variables.

Table 6. Bonferroni multiple comparisons based on observed means for EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04 by sectors.

	G1		G2		G3		G4		G5		G6	
	Benefit	Mean diff.	Benefit	Mean diff.	Benefit	Mean diff.	Benefit	Mean diff.	Benefit	Mean diff.	Benefit	Mean diff.
G1	–	–	–	–	EI06	0.599	EI06	0.612	EM01 EM03	−0.496 −0.502	EI06	0.605
G2			–	–	EM03 EM04 EI03 EI04 EI06	−0.499 −0.584 0.592 0.514 0.499	EM01 EI03 EI06	0.496 0.591 0.511	EM03 EM04	−0.559 −0.588	EM01 EI06	0.497 0.505
G3					–	–	EM03 EM04 EA04	0.475 0.500 0.494	EM03 EI03 EI04 EI05 EI06	−0.535 −0.605 −0.562 −0.433 −0.564	–	–
G4							–	–	EM01 EM03 EM04 EI03 EI04 EI06	−0.512 −0.535 −0.504 −0.603 −0.522 −0.576	–	–
G5									–	–	EM01 EM03 EI06	0.513 0.519 0.570

(d) Discriminant analysis results

The discriminant command in SPSS does a stepwise linear discriminant analysis, which is the most used type of discriminant analysis. The command is adjusted to use stepwise variable selection, Wilks' Lambda method, 0.1 probability of F entry, and 0.2 probability of F removal. At every step of the solution, a variable that reduces the overall Wilks' Lambda is introduced. Table 7 shows that ten ISO 14001 benefits were entered into the analysis: EI06, EM03, EI03, EA04, EM01, EM04, EM02, EI02, EI01, and EI04 as a result of applying the discriminant analysis algorithm (Sig. < 0.05). These variables participate in classifying the industrial sectors in groups and have a significant statistical effect of these variables on classifying industrial sectors. EI05, EA01, EA02, and EA03 were removed from the analysis by the discriminant analysis algorithm due to (Sig. > 0.05).

Table 7. Variables in the analysis.

Variable	Wilks' Lambda											
	Statistic	df1	df2	df3	Exact F				Approximate F			
					Statistic	df1	df2	Sig.	Statistic	df1	df2	Sig.
EI06	0.768	1	5	114.000	6.875	5	114.000	0.000	–	–	–	–
EM03	0.561	2	5	114.000	7.585	10	226.000	0.000	–	–	–	–
EI03	0.419	3	5	114.000	–	–	–	–	7.639	15	309.584	0.000
EA04	0.336	4	5	114.000	–	–	–	–	7.189	20	369.095	0.000
EM01	0.281	5	5	114.000	–	–	–	–	6.686	25	410.134	0.000
EM04	0.228	6	5	114.000	–	–	–	–	6.522	30	438.000	0.000
EM02	0.191	7	5	114.000	–	–	–	–	6.290	35	456.745	0.000
EI02	0.162	8	5	114.000	–	–	–	–	6.078	40	469.197	0.000
EI01	0.147	9	5	114.000	–	–	–	–	5.684	45	477.267	0.000
EI04	0.132	10	5	114.000	–	–	–	–	5.387	50	482.238	0.000

Five discriminant functions were found to be statistically significant as shown in Tables 8 and 9. Wilks' $\Lambda = 0.132$, Chi-square = 2240.651, and Sig = 0.000 for discriminant function 1 through 5. Wilks' $\Lambda = 0.289$, Chi-square = 137.806, and Sig = 0.000 for discriminant function 2 through 5. Wilks' $\Lambda = 0.448$, Chi-square = 890.175, and Sig = 0.000 for discriminant function 3 through 5. Wilks' $\Lambda = 0.631$, Chi-square = 510.106, and Sig = 0.000 for discriminant function 4 through 5. Wilks' $\Lambda = 0.833$, Chi-square = 200.322, and Sig = 0.002 for discriminant function 5. The five discriminant functions explain 44.5%, 200.6%, 150.3%, 120.0%, and 7.5% of the variance. Canonical correlations are 0.737, 0.596, 0.539, 0.492, and 0.409 for discriminant functions, indicating that 540.3%, 35.5%, 290.1%, 24.2%, and 16.7% of variances were explained by the association between explanatory variables and group membership by the five discriminant functions, respectively. The first discriminant function had the largest relationship with EI01, followed by EI03, EI04, EM04, EI06, EI02, EM02, EM03, EM01, and EA04. The second discriminant function had the most significant relationship with EM04, followed by EM02, EI06, EA04, EI01, EI03, EI04, EM03, EI02, and EM01. Discriminant function 3 has the largest relationship with EM03, followed by EI04, EM01, EI03, EI06, EI02, EM02, EA04, EI01, and EM04. Discriminant function 4 has the largest relationship with EI03, followed by EI01, EM01, EM02, EM03, EM04, EI04, EI06, EA04, and EI02.

Table 8. Eigenvalues for canonical discriminant functions.

Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	10.187	44.5	44.5	0.737
2	0.550	200.6	650.1	0.596
3	0.409	150.3	80.5	0.539
4	0.320	120.0	92.5	0.492
5	0.201	7.5	1000.0	0.409

Table 9. Wilks' Lambda for canonical discriminant functions.

Test of Function(s)	Wilks' Lambda	Chi-Square	df	Sig.
1 through 5	0.132	2240.651	50	0.000
2 through 5	0.289	137.806	36	0.000
3 through 5	0.448	890.175	24	0.000
4 through 5	0.631	510.106	14	0.000
5	0.833	200.322	6	0.002

Discriminant function 5 has the largest relationship with EA04, followed by EI02, EM03, EM02, EM04, EI01, EI04, EI03, EM01, and EI06. These relationships were deduced using data given in the standardized Canonical Discriminant Function (CDF) coefficient Table 10. Table 11 presents the classification results for original and cross-validated cases. Cross-validation is performed only for the cases included in the analysis. During cross-validation, every case is grouped by the functions generated from all other cases other than that specific case. The table below indicates that 13 G1 observations remained in the same group by the classifier, 2 cases classified in G4, 2 cases classified in G5, and 3 cases were classified in G6, representing 65%, 10%, 10%, and 15% from a sample size of 20 cases. A total of 69.2% of originally classified cases were correctly grouped, and 550.0% of cross-validated grouped cases were correctly classified based on the data given in Table 11.

Table 10. Standardized canonical discriminant function coefficient.

Variable	Function				
	1	2	3	4	5
EM01	0.381	0.386	−1.134	−0.226	0.484
EM02	0.527	−0.792	−0.214	−0.385	−0.306
EM03	−0.734	0.806	0.123	0.213	−0.168
EM04	−0.756	0.411	0.859	0.205	0.085
EI01	−0.575	−0.188	−0.326	−0.032	−0.607
EI02	−0.604	−0.525	−0.384	−0.096	−0.002
EI03	0.884	0.487	−0.193	0.890	−0.129
EI04	0.342	−0.184	0.576	0.620	0.062
EI06	0.819	0.438	0.537	−1.229	0.083
EA04	−0.197	−0.522	0.199	0.074	1.018

Table 11. Classification results.

Sector	Predicted Group Membership														
	Count							% Total							Total
	G1	G2	G3	G4	G5	G6	Total	G1	G2	G3	G4	G5	G6	Total	
Original	G1	13	0	0	2	2	3	20	65	0	0	10	10	15	100
	G2	3	12	2	1	1	1	20	15.0	60.0	10.0	5.0	5.0	5.0	100
	G3	1	0	15	3	0	1	20	5.0	0.0	75.0	15.0	0.0	5.0	100
	G4	2	0	1	15	1	1	20	10.0	0.0	5.0	75.0	5.0	5.0	100
	G5	1	2	2	0	14	1	20	5.0	10.0	10.0	0.0	70.0	5.0	100
	G6	0	1	1	3	1	14	20	0.0	5.0	5.0	15.0	5.0	70.0	100
Cross-validated	G1	11	0	1	3	2	3	20	55	0	5	15	10	15	100
	G2	3	10	2	2	2	1	20	15.0	50.0	10.0	10.0	10.0	5.0	100
	G3	1	1	12	4	0	2	20	5.0	5.0	60.0	20.0	0.0	10.0	100
	G4	4	0	3	9	1	3	20	20.0	0.0	15.0	45.0	5.0	15.0	100
	G5	1	2	3	0	13	1	20	5.0	10.0	15.0	0	65.0	5.0	100
	G6	1	1	2	4	1	11	20	5.0	5.0	10.0	20.0	5.0	55.0	100

4. Discussion

The results presented here provide two main findings that enhance our understanding of the 14 cited benefits of adopting ISO 14001 based on environmental managers' perceptions working in six industrial sectors located in Saudi Arabia. First, the MANOVA results show that ISO 14001 mean benefits, as measured by the 9-Likert scale, are significantly different among the six industry types. Second, the discriminant analysis results show that 10 of the 14 benefits discriminate between sectors. In the following, we will discuss how these results might be important for shedding light on the development of the international standard ISO 14001. To the best of our knowledge, this study's objective was not covered in the literature. Because obtaining the ISO 14001 certificate is very expensive, it is necessary to plan well to assign organizations' resources to obtain the greatest benefits from the certificate. A sample of 120 environmental managers working in six sectors in Saudi Arabia was analyzed using MANOVA and discriminant analysis to investigate the benefits scale. As presented in Table 4, MANOVA results revealed that the linear combination of EM01, EM02, EM03, EM04, EI01, EI02, EI03, EI04, EI05, EI06, EA01, EA02, EA03, and EA04 was significantly different among sectors. It seems likely that these results are, in fact, due to the noticeable variation of the impact of the standard on the 14 benefits. Though some studies observed improvements in benefits, some studies did not observe a substantial change. This is in line with the work performed by Boiral and Guillaumie [3] concerning the disagreement from researchers about the effect of ISO 14001 implementation and the firm's benefits.

ANOVAs were significant, implying that there were significant differences in EM01, EM03, EM04, EI03, EI04, and EI06 among sectors. These results are in line with the opinions calling for a positive impact of ISO 14001 adoption on EM01 [6,7,33], a positive impact

of EM03 [11,12], a positive impact of EM04 [14], and disagree with the opinions calling for no impact mentioned by [12,13] regarding EM04. We can conclude from the conflict of opinions regarding EM04 that organizations, in general, find ISO 14001's adoption as an additional administrative burden on employees due to the use of an environmental documentation system in addition to the traditional administrative documentation system used in it, but our results confirm that applying the standard increases the ability of organizations to control its documents, especially those concerned with environmental management. To reduce the documentation effort, we propose combining ISO 9001:2015, ISO 14001:2015, and ISO 45001:2018 in one standard concerning quality, environment, and safety management in organizations. Our results are consistent with many studies supporting a positive impact between EM03 and adoption of the standard as [6,10,23] and conflicts with no impact opinions concluded by [7,11,19]. This conflict in results may be explained by the differences that may exist in the implementation of the ISO 14001 system among organizations. Evaluation of researchers about ISO 14001's adoption impact on EI04 came in conflict, while their evaluation was similar to our evaluation [15–17,31], except the work performed by [19,24] came with an evaluation of no significant impact. This can be explained by some organizations were able to maintain the same performance for EI04, while others were able to achieve a tangible positive effect, which does not conflict with the application of the ISO standard. Concerning water contamination, our results are consistent with the opinions of a positive effect between EI06 and ISO 14001 adoption and in line with the results of [27,28] and opposite to the opinions of no effect for [18,19,21]. This can be explained by the fact that references [27,28] evaluate the relationship in 19 and five industrial sectors while [18,19,21] evaluate the relationship in manufacturing organizations only. Consequently, our results came consistent with opinions that considered multiple industrial sectors in their evaluation. This supports that the sector type is an influencing factor in evaluating the effect of implementing the standard on EI06.

ANOVAs were significant, indicating that there were no significant differences in EA04, EI05, EA01, EI01, EM02, EI02, EA02, and EA03 among sectors, as shown in Table 5. For example, the EM01 scale resulted in $F(5, 114) = 50.402$, $p < 0.000$, partial $\eta^2 = 0.192$, and observed power = 10.00. The effect size was large for ANOVAs (partial $\eta^2 > 0.14$) [52]. The strength of the relationship between the type of industrial sector and EM01, EM03, EM04, EI03, EI04, or EI06 was strong, the type of group accounting for 19.2 %, 190.3 %, 160.3 %, 230.0 %, 160.3 %, 23.2 % respectively of the variance of the outcome variable. The observed powers of 0.987, 0.988, 0.963, 0.998, 0.963, and 0.998 indicated that there was a high possibility that the results could have come out for analysis. These results are in line with {[14], [12,15,25,26], [15–17,30,31], [15–17], [8–10], [17,18,20], [33,34], [33,34], [35,37]} for a positive impact for benefits and contrary to the opinions that claim that there is no impact of [–, [29], –, [19,24], –, [19,21,22], [35,36], [16]] respectively as shown in Table 1. The lack of difference between the six sectors in the evaluation of these benefits can be explained by the fact that they are direct benefits that are achieved after the implementation of the system, such as regulatory compliance, manager's involvement, etc. The partial η^2 , Table 5, for EI05, EA01, and EA04 belongs to the interval [0.06, 0.14], indicating a medium effect size for ANOVAs. The observed powers of these variables are 0.819, 0.652, and 0.844, respectively. The strength of the relationship between the type of industrial sector and EI05, EA01, or EA04 was medium, the type of group accounting for 110.0%, 80.1%, and 11.5%, respectively of the variance of the dependent variable. The observed powers of 0.819, 0.070, and 0.844 indicated that there was a medium likelihood that the findings could have come out for analysis. The effect size was small for ANOVAs of EM02, EI01, EI02, EA02, and EA03 (partial $\eta^2 < 0.06$). The observed powers of these variables are 0.135, 0.149, 0.112, 0.085, and 0.070 respectively. The strength of the relationship between the type of industrial sector and EM02, EI01, EI02, EA02, or EA03 was small, the type of group accounting for 1.5%, 1.7%, 10.0%, 0.7%, and 0.4% respectively of the variance of the dependent variable. The observed powers of 0.135, 0.149, 0.112, 0.085, and 0.070, which indicated that there was a small likelihood that findings could have come out for analysis.

As shown in Table 6, Bonferroni's multiple comparisons results showed that there is no difference in ISO 14001 benefit evaluation between sector pairs of (G1, G2), (G3, G6), and (G4, G6). By comparing the benefits of ISO 14001 certification according to the perceptions of environmental managers for the six sectors, it was shown that G1 evaluated EI01 greater than G3, G4, and G6 with significant mean differences of 0.599, 0.612, and 0.605, respectively, while G1 evaluated EM01 and EM03 with mean significant differences of 0.599 and 0.612 less than their counterparts for sector G5. By comparing G2 with G3, it was found that it assesses ISO 14001 benefits with significant differences mean greater than G3 for EI03, EI04, and EI06 with values of 0.592, 0.514, and 0.499, respectively, while it assesses EM03 and EM04 with mean significant differences of 0.499 and 0.584, as shown in Table 6. G2 assessed EM01, EI03, and EI06 with mean significant differences of 0.496, 0.591, and 0.511, respectively, more than G4. While G2 assessed EM03 and EM04 less than G5 with significant mean differences of 0.559 and 0.588, it assessed EM01 and EM06 with significant mean differences of 0.497 and 0.505 more than the G6 assessment. Considering G3, Table 6 shows that it is more concerned with EM03, EM04, and EA04 than G4, with significant mean differences of 0.475, 0.500, and 0.494. By comparing G3 with G5, we found that G3 evaluated the benefits of implementing ISO 14001 with a lower significant mean difference for five discriminating benefits (EM03, EI03, EI04, EI05, and EI06) with significant mean differences of 0.535, 0.605, 0.562, 0.433, and 0.564 respectively. According to this study's results, it was found that sector four does not differ from other sectors except for sector five; it assessed the benefits EM01, EM03, EM04, EI03, EI04, and EI06 with significant mean differences of 0.512, 0.535, 0.504, 0.603, 0.522, and 0.576 less than G5. Concerning G5, it has significant differences for benefits more than G6 by mean of 0.513, 0.519, and 0.570, as shown in Table 6.

As shown in Table 7, discriminant analysis results implied that EI06, EM03, EI03, EA04, EM01, EM04, EM02, EI02, EI01, and EI04 are listed to discriminate sectors and have a significant statistical effect. Additionally, EI05, EA01, EA02, and EA03 were removed from the analysis. The results implied that 10 benefits out of the 14 that discriminated against sector five are EIs, 4 EMs, and one EA. The results show that 5 EIs (water contamination, general environmental performance, pollution of air, waste reduction and management, and energy and resources consumption) have a significant discriminant effect on classifying the six sectors. It seems likely that these results are, in fact, due to the importance of EIs for organizations in different sectors varies, as organizations focus on using indicators that directly reflect their activities and have direct effects on their cost and competitiveness. Furthermore, results show that the four EM benefits, EM01, EM02, EM03, and EM04, have a significant discriminant effect on classifying the six sectors. It seems likely that these results are, in fact, due to the variation in management procedures and administrative efforts adopted by organizations working in different sectors. Regarding the EA dimension, results show that managers' involvement benefit has a significant discriminant effect on classifying the six sectors. It seems likely that these results are, in fact, due to ISO 14001 in clause 50.1 restricts that management should demonstrate leadership and commitment to the EMS [53]. Thus, this benefit varies from one sector to another based on the manager's effort to reduce the effect of their processes on the environment.

There may be some possible limitations in this study. The first is that possible methodological limitations of the study were a lack of prior research studies on the topic due to the difficulty in collecting reliable data from organizations in different countries. This allows researchers to develop an entirely new research typology in comparing ISO 14001 benefits based upon robust statistical techniques such as N-ways MANOVA and profile analysis as a need for further development in the area of study. The second limitation concerns the perception scale assumed that the variables are independent and may affect the study's results. This opens a chance for making pairwise comparisons among benefits pairs and the use of analytical hierarchal process methodologies to further investigate the effects of implementing the standard. The third limitation concerns the long period of sampling that may affect the results of the study and open a research direction for monitoring the per-

ceptions of environmental managers towards the standard implementation by increasing the years of receiving the ISO 14001 certificate. Finally, a possible cultural limitation of contacting environmental managers of females in Saudi Arabia due to the religious nature of the country leads to a lack of females who works as environmental managers.

5. Conclusions

In this study, we examined the industrial sectors' perceptions of the benefits of implementing the ISO 14001 standard in Saudi Arabia using MANOVA-DA methodologies. The benefits were categorized into three main categories: environmental management, environmental indicators, and environmental awareness and social aspects. The environmental management category includes rigor and effectiveness of practices, regulatory compliance, greener supply chain, and documentation control. Environmental indicators include waste minimization and management, air pollution, environmental performance in general, energy and resources consumption, environmental risks and safety issues, and water contamination. Environmental awareness and social aspects benefits include image and stakeholders, employee involvement, employee training and knowledge, and manager involvement. We compared the mean vectors of environmental managers' perceptions of implementing the standard for 120 organizations belonging to six industrial sectors: fibers and chemicals, plastic and rubber products, fabricated metal products, construction, wholesale and retail trade, and engineering services fields. MANOVA results showed that the mean vector representing the evaluations of environmental managers was not equal to the benefits of implementing ISO 14001. Results of the discriminant analysis showed that 10 of 14 benefits could be considered discriminant factors for sectors, where the benefits of environmental management and environmental indicator dimensions were more able to discriminate sectors than the benefits of EA dimensions. Although the previous results indicated that there is a discrepancy in the effect of adopting ISO 14001 in general on the dimensions of environmental management, environmental performance indicators, and environmental awareness, from a positive effect to no effect, our study proved a positive relationship between the ISO 14001 adoption and the 14 environmental benefits mentioned in this study.

The results may differ if measured for other industries not covered in this study. Furthermore, results may vary according to the geographical scope of data collection on a global scale. In addition, the study's results can vary according to the company's size and the number of years of ISO 14001 certification. Regardless, our results indicate the need for practitioners and ISO 14001' implementers to reconsider determining the relative benefit importance and allocating their resources to achieve the greatest benefits levels at the lowest costs, with priority given to environmental performance indicators that directly affect the environment. Our results open a new avenue of study that focuses on studying the disparity between the benefits of implementing ISO 14001 on a global scale, which will provide basic information and data sources that can be used to identify EIs for each industry that can be integrated into the development of the international standard. If the benefits vary on a global scale, it is possible to make a kind of normalization of these benefits for ease of comparing the benefits of organizations in different sectors and linking this to the allocated funds of the organizations to monitor and improve the implementation of ISO 14001 standard. Finally, a natural expansion of this study might be the use of other discriminant analysis methodologies. Furthermore, there is an urgent need to investigate combining ISO 9001:2015, ISO 14001:2015, and ISO 45001:2018 in one standard that has a significant impact on reducing the administrative efforts made by institutions to maintain quality, environment, and safety for their work.

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Appendix A

Table A1. Perceptions about the Benefits of Implementing ISO 14001 Standard Questionnaire.

A 9-Point Likert Scale Questionnaire Importance Evaluation of ISO 14001:2015 Benefits								
Organization official name:								
Organization's economic activity: please, select one economic activity for your organization.								
(a) Chemicals, chemical products & fibers	☐	(b) Construction	☐					
(c) Rubber and plastic products	☐	(d) Wholesale & retail trade, repairs of motor vehicles, motorcycles & personal & household goods	☐					
(e) Basic metal & fabricated metal products	☐	(f) Engineering services	☐					
Organization size:	low ☐	Medium ☐	Large ☐					
ISO 14001 year of certification:								
Before 2006 ☐	2006–2007 ☐	2008–2009 ☐	After 2009 ☐					
Sex:	Male ☐	Female ☐						
Age:	35–45 years ☐	46–50 years ☐	Above 50 years ☐					
Position:								
CEO ☐	President ☐	Vice President ☐	Manger ☐					
Years of experience in current position:								
2–5 years ☐	6–10 years ☐	Above 10 years ☐						
For the next 14 questionnaire items, please choose a number from 1–9 and mark the appropriate importance below to indicate how much you agree with this statement.								
Extremely Unimportant	Very Unimportant	Unimportant	Maybe Unimportant	Unsure	Maybe Important	Important	Very Important	Extremely Important
1	2	3	4	5	6	7	8	9
1. Please rate the importance of "Rigour and effectiveness of practices" benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
2. Please rate the importance of "Regulatory compliance" benefit from implementing ISO 14001:2015 standard in your organization as a 9-point scale.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
3. Please rate the importance of the "Greener supply chain" benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
4. Please rate the importance of "Documentation control" benefit from implementing ISO 14001:2015 standard in your organization.								

Table A1. Cont.

A 9-Point Likert Scale Questionnaire Importance Evaluation of ISO 14001:2015 Benefits								
☐	☐	☐	☐	☐	☐	☐	☐	☐
5. Please rate the importance of “Waste minimization and management” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
6. Please rate the importance of “Air pollution” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
7. Please rate the importance of “Environmental performance in general” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
8. Please rate the importance of “Energy and resources consumption” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
9. Please rate the importance of “Environmental risks and safety issues” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
10. Please rate the importance of “Water contamination” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
11. Please rate the importance of “Image and stakeholders” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
12. Please rate the importance of “Employee’s involvement” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
13. Please rate the importance of “Employee’s training and knowledge” benefit from implementing ISO 14001:2015 standard in your organization as a 9-point scale.								
☐	☐	☐	☐	☐	☐	☐	☐	☐
14. Please rate the importance of “Manager involvement” benefit from implementing ISO 14001:2015 standard in your organization.								
☐	☐	☐	☐	☐	☐	☐	☐	☐

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