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Environmental Management System ISO 14001: Effective waste minimisation in small and medium enterprises in India

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Abstract
Numerous empirical and conceptual studies describe waste minimisation as a key environmental performance indicator for industry. ISO 14001 certification in this regard is widely considered the tool of choice for driving waste minimisation efforts. To this day, however, the evidence remains mixed as it pertains to the effectiveness of ISO 14001 in helping firms reduce waste, especially in developing countries. This paper explores the waste minimisation efforts among Indian small and medium enterprises. Specifically, improvements in waste minimisation are analysed from small and medium enterprises operating in the cities of Delhi and Noida. Our proposed model is tested for a model-fit, and the hypotheses are tested through regression coefficient ($\beta$) scores to determine the influence of ISO 14001 on the degree of waste minimisation among certified and non-certified companies. The data reveal that ISO 14001 certification alone helped account for a 25% increase in waste minimisation in certified companies after controlling for other critical factors (correlated to the variable ‘waste minimisation’) that may influence this relationship. The analytical tools described in this paper lend themselves to be applied to similar research problems in future studies. The study provides baseline data for further research into ISO 14001 effectiveness in the Indian SME context - a field with still only limited research insights - and offers policy prompts for targeted environmental management improvements in Indian firms.

Keywords: environmental management systems, small and medium-sized enterprises, waste minimisation, environmental performance, ISO 140001, legal compliance, India, policies

1. Introduction
The Indian small and medium enterprise (SME) market is of great economic significance valued at US$5 billion (Basha, 2013). The country’s 1.3 million SMEs constitute over 80% of the total number of industrial enterprises in India, account for over 35% of the gross value of output in the manufacturing sector and make up over 40% of total exports (Das et al., 2007; Goyal, 2013). India’s small-scale industries help generate income and investment in the economy and provide employment to more than 32 million people, who account for 45% of the country’s total industrial employment (Ravi, 2009).

However, at the same time, 70% of all industrial pollution is attributable to the nation’s SME sector (Indian Ministry of Environment and Forests (MOEF, 2012), which explains growing calls for policy changes and improved production processes. Table 1 below lists India’s most polluting sub-sectors amongst SMEs.

Place Table 1: India’s most polluting industries (Central Pollution Control Board, 2014)

Industrial waste is particularly problematic in light of the fact that India lacks adequate waste treatment and disposal facilities for the hazardous wastes generated by the country’s many manufacturing industries. The waste problem is compounded further by poor waste handling practices and illegal waste dumping, which have been found to be the cause of alarming rises in pollution to soil and groundwater, representing not only a human health hazard but also an increasingly pressing commercial concern for the SME sector in India (see Moturi et al., 2004; Saxena and Bhattacharyya, 2010; Wath et al., 2011; Hindustan Times, 2012).

Globally, ISO 14001 is the most widely recognised and most frequently used standard for environmental management systems (EMSs) (Szekely and Knirsch, 2005; Bracke and Albrecht 2007; Montiel, Husted and Christmann, 2012). Certification to the standard is purported to foster the development not only of cleaner, safer and healthier products and workplaces but also to lead to improved environmental outcomes and economic benefits (Lesourd and Schilizzi, 2001; Melynk et al., 2003; Tari et al, 2012). In this regard, ISO 14001 certification could be regarded an ideal vehicle for waste minimisation in India’s...
SME sector. Empirically, however, the evidence of ISO 14001 efficacy remains mixed (Prajogo et al., 2012; Potoski and Prakash, 2013), and to this day still only little is known about the effectiveness of certified environmental management systems in developing countries in general and in India’s SME sector in particular (Singh, Brueckner and Padhy, 2014).

It is against this background that this paper offers an evaluation of the impact of ISO 14001 certification on waste minimisation efforts in Indian SMEs and their overall environmental performance. To this end, a review is presented of the literature on the relationship between EMSs and waste minimisation to help formulate a set of research hypotheses, which are then tested against empirical data collected from both ISO certified and non-certified SMEs operating in the two large industrial Indian cities of Delhi and Noida. In recognition of the heterogeneity of the MSME sector (see Hillary, 2004), the focus here will be restricted to SMEs with an annual turnover on sales above 10 million INR (~US$ 168 000). The results will then inform a discussion on ISO effectiveness as it pertains to waste minimisation and environmental performance as well as on policy implications.

2. Waste minimisation and the Indian context

Despite concerted policy efforts, volumes of industrial and municipal waste continue to grow globally due to a growing world population and rising per capita incomes and consumption (Worldwatch Institute, 2012; UNEP, 2012). Around 4 billion tons of waste are produced annually (Chalmin and Gaillochet, 2009), and this figure is expected to rise in future with solid waste volumes alone tipped to double by 2025 (Hoornweg and Bhada-Tata, 2012). Growing waste volumes are a key management concern for waste may be toxic, ignitable, corrosive or reactive and can thus prove hazardous to both human and environmental health (e.g. Giusti, 2009; Samuelson 2009). Also, while business and industry were not overly concerned about waste generation in the past, waste generation today is often associated with high costs to firms’ bottom line and increased legal compliance pressures (WBCSD, 2002; National Audit Office, 2010), not to mention growing environmental impacts (Worldwatch Institute, 2013); this explains the growing interest in waste minimisation techniques and practices in the business and policy realms (Wilson et al., 2012).

Waste minimisation (WM), also often referred to as source reduction, pollution prevention or green manufacturing, has a wide currency (Mulholland and Dyer, 1999). Whilst seen by some as any measure that reduces the amount of waste requiring final disposal (Kavanagh, 1994), WM is strictly defined in terms processes and practices that prevent or at least help reduce the actual generation of waste (UNEP, 2002) and is thus the preferred of all waste management options. Yet, WM commonly entails a combination of prevention techniques, quality improvements and recycling initiatives that serve to reduce the amount of waste produced and help eliminate the generation of harmful and persistent wastes. WM often includes product and process redesign but also extends to changes in societal patterns driving consumption and production and thus affecting waste generation (OECD, 1996; EEA, 2002;

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1In India, enterprises are distinguished in terms of their investments in plant and machinery as well as investments in equipment. Companies with investments in plant and machinery of up to US$62 500 and investments in equipment of up to US$25 000 are considered micro enterprises. Small enterprises are those with investments in plant and machinery between US$62 500 and US$1.25 million as well as investments in equipment between US$25 000 and US$0.5 million. Medium enterprises have investments in plant and machinery between US$1.25 million and US$2.5 million and investments in equipment between US$0.5 million and US$1.5 million (SMBDCI, 2012).
Sharp et al., 2010). Notwithstanding, the key emphasis is commonly placed on the adoption of Cleaner Production (CP) technologies as a means of bringing about waste reductions and achieving waste prevention. Staniskis and Stasiskiene (2005), for example, reveal in their review of WM programs that causes of waste generation are often ignored. Instead, WM programs are found to focus on waste and its analysis, identification, characterisation and sorting. In their study of Lithuanian SMEs, Staniskis and Stasiskiene (2005) show that the companies’ waste minimisation efforts are largely technologically focused, entailing Cleaner Production practices such as technology modification, process optimisation, on-site recycling and energy recovery.

Firms can achieve effective waste minimisation by way of adopting and integrating waste minimisation programmes that institute organised, comprehensive and continual efforts to systematically reduce waste generation. Effective programmes critically rely on the commitment by senior management and good programme oversight as well as effective waste stream identification and analysis (Cheremisinoff, 2001; El-Halwag, 2012). Firms can use tailored prevention techniques to target critical waste streams, work towards the elimination of waste and bring about environmental management improvements with possibly considerable associated business savings (Granek, 2011). Various studies have linked effective waste minimisation to a whole raft of business benefits including improved financial performance, productivity and operational efficiencies (e.g. Nishitani et al., 2012; Testa et al., 2012; Albertini, 2013). In this context, the relevant question here is whether EMSs can help firms improve their waste minimisation efforts and outcomes.

2.1 Waste minimisation and ISO 14001 certification

There is a growing body of research pointing to a positive relationship between firms’ environmental management systems and their success in improving their overall environmental performance (for an overview see Ferenhof, 2014). For example, studies by Kitazawa and Sarkis (2000), Iraldo et al. (2009) and Martin-Pena (2014) demonstrate how ISO 14001 EMS and EMS like standards assist organizations in operating source reduction programs and help produce environmental benefits including improved waste processing. Especially for SMEs, ISO 14001 was found to be particularly valuable because of the standard’s systematic nature (Granly and Welo, 2014) and in light of SME’s varied production modes and great diversity of pollutants they produce (Seiffert, 2008).

With regards to waste minimisation, various European studies (see Steger 2000; Hillary, 2004; Agan et al., 2013; Testa et al., 2014) have shown that that resource efficiency and pollution prevention were rated highly among firms as a tangible outcome of EMS implementation with similar findings produced by research in Brazil (Oliveira et al., 2010; Gavronski et al., 2013), the US (Melnyk et al., 2003; Franchetti, 2011) and Asia (Nguyen and Hens 2013; Zhang et al., 2014). Furthermore, the work by Potoski and Prakash (2005) and Massoud et al. (2012) suggests that ISO 14001 certified firms experience significantly larger reductions in pollution when compared to non-certified companies. Also, studies by Zorpas (2010), Franchetti (2011), Comoglio and Botta (2012) describe improvements in firms’ waste management following EMS implementation. In the Indian context, the work by Khanna (2010b) – while pointing to a limited uptake of formal EMSs among Indian SMEs – overall attests to the environmental effectiveness of EMSs among ISO 14001 certified firms.

At the same time, various studies draw into question the linkages that are said to exist between certified and non-formalised EMSs and waste minimisation outcomes and in this regard challenge assertions about EMS effectiveness. While EMS adoption since 1999 has
markedly grown among SMEs, overall waste production has also been found to have trebled (Gerven et al., 2006), arguably producing only mixed environmental performance results among firms following ISO 14001 implementation and certification (see Turberfield, 2002; Boiral, 2007). Barla (2007) and Gomez and Rodriguez (2011) also could not point to any empirical evidence showing EMS certification to cause a reduction in pollution levels. Further, Ilomaki and Melanen (2001) found that raw material cost as opposed to EMS certification were the key impetus for waste reduction efforts among Finnish SMEs, questioning ISO 14001 as an effective driver of waste minimisation. Certification may also be sought for reasons other than environmental improvement. Fryxell et al. (2004), for example, saw legal compliance and reputation enhancement as opposed to environmental performance improvements largely driving ISO 14001 uptake among Chinese firms. Similarly, Santos et al. (2011) found environmental protection as only one of a number of drivers of EMS adoption among Portuguese SMEs.

Various studies have also cast doubt over the suggested differences in environmental performance between ISO 14001 certified and uncertified firms. Zobel (2013), for example, found no difference in environmental performance between certified and non-certified firms except that the waste production in certified firms increased by only 7% as compared to a 35% increase observed in non-certified firms. Similarly, Barla (2007) could not identify discernible differences in environmental performance among certified and non-certified Canadian pulp and paper companies. Indeed, Amin and Banerjee’s (2010) study on Indian steel mills suggests that peer companies operating under voluntary compliance regimes show better environmental performance results when compared to their ISO 14001 certified counterparts.

Overall, it is fair to suggest that studies on EMS effectiveness have produced heterogeneous outcomes, which could be seen as a function of what is regarded an insufficient and ineffective empirical evaluation of EMSs efficacy (Strasser, 2011; Ferenhof et al., 2014). While some authors such as Hertin et al. (2008) raise methodological concerns about comparisons between EMSs and firms’ environmental performance and question whether ISO 14001 certification leads to improved environmental outcomes, others call for greater consistency in indicator design and greater clarity when defining environmental performance (Jash, 2000; Rao et al., 2006; Hussey and Egan, 2007; Nawroka and Parker, 2009). Aravind and Christmann (2011) are critical of the overall lack of attention paid to EMS implementation and its connection to firms’ environmental performance, suggesting the decoupling of standard implementation from EMS certification. In this regard, Nawroka and Parker (2009) argue that the research focus ought to shift away from questions of whether or not EMSs affect performance and instead target the issue of how performance might be affected.

As was shown previously, the SME sector is a vital part of the Indian economy, and its future success will critically determine the country’s future development. At the same time, SMEs contribute chiefly to India’s total industrial pollution load. This explains the need to address the environmental challenges the sector faces and to explore the role EMSs can play in this context. The above review of the literature made plain, however, that further empirical work is required to establish stronger links between ISO 14001 uptake and certification and firms’ environmental performance in general and waste minimisation in particular. This study seeks to contribute by way of shedding light on the impact of EMSs on Indian SMEs’ environmental performance. Specifically, the research underlying this paper focused on the
question of whether waste minimisation differs between ISO 14001 certified and non-certified Indian SMEs and the factors contributing to it.

In what follows we describe the research framework developed for the purposes of this study. We establish a set of research hypotheses, which are then tested to ascertain the degree to which EMS uptake and certification drive environmental improvements in Indian SMEs.

3. Study design

The study reported on here tests the relationship between firms’ certification status and their environmental management performance, understood in terms of waste management. Specifically, the study seeks, and is designed to test research hypotheses to analyse this relationship.

3.1 Research framework and hypotheses development

There is growing empirical evidence in support of a positive relationship between ISO 14001 certification and firms’ environmental management performance (e.g. Melnyk et al., 2003; Potoski and Prakash, 2005; Iraldo et al., 2009; Martin-Pena, 2014; Ferenhof, 2014). In this context, the literature points to so-called ‘critical factors’ (see Padma et al., 2008) that are said to affect ISO 14001 effectiveness, and Amin and Banerjee (2010) call for further research into these factors to create a better understanding of the state of ISO 14001. Various studies have already explored the impact of various factors on EMS efficacy. Singh, Brueckner and Padhy (2014), for example, explore the role of factors such as nature of business, business size, internationalisation, age of business and firms other certification experiences, while the work by Stevens et al. (2012) focuses on organisation size, cladistics and the use of quality management concepts. Furthermore, Melnyk et al. (2003) study the state of the EMS, age of the EMS (years), resource availability (4 quartile sales) and nature of company ownership as factors affecting EMS effectiveness. Padma et al. (2008) target factors such as international exposure, export orientation and experience as key aspects affecting the effectiveness of ISO 14001. A recent study by Singh et al. (2014) controlled the above variables, designating them as firms’ characteristics because of their significant influence on firms’ decision-making and adoption of proactive environmental management practices.

Based on Singh, Brueckner and Padhy’s (2014) work in the Indian context five factors are chosen as covariates for the purposes of this study. The rationale for their selection is presented below.

- nature of business;
- resource availability;
- number of employees;
- international exposure; and
- number of environmental options.

Nature of business

Nature of business of SMEs in this study refers to either manufacturing or service. The relationship between the nature of firms’ activities and their ISO 14001 certification status has been established by several studies. Manufacturers are generally found to be the first movers in ISO 14001 certification (Blackman, 2012; King et al., 2005; Lagodimos, 2007; Singh et al., 2014). However, the service SMEs (mostly represented by the IT sector) in the
study area are significant generators of solid waste in the form of E-waste (white goods, cellular phones and PCs) as well as scrap metal, packaging/paper and plastics, which can prove hazardous to human if managed incorrectly (Wath et al., 2011). Many countries have already worked towards E-waste management. However, the impact of ISO 14001 certification in connection with E-waste was beyond the scope of this study. It is assumed for the purposes of this paper that the nature of the businesses studied will have a measurable impact also on their environmental performance (waste minimisation), and the ‘nature of business’ is thus chosen as one of the independent variables for this study that could independently contribute to the extent of firms’ waste minimisation efforts. As suggested by Singh et al.(2014), more sophisticated environmental management practices can be found in the manufacturing sector when compared to the service sector, which Zobel (2013) attributes to a stronger interest in environmental performance among manufacturing firms; this, however, is yet to be determined empirically.

Resource availability and number of employees
Cost of certification is widely recognised as a certification barrier. Unsurprisingly many studies find ISO uptake to occur primarily among larger firms with the requisite financial means (e.g. del Brio et al., 2001; Hillary, 2004; Lagodimos et al., 2007; Nishitani, 2009; Khanna, 2010a; Campos, 2012; Agan et al., 2013; Halila and Tell, 2013). Similarly, SMEs among the 200 small and large companies in Hong Kong studied by Chan and Li (2010) regard a lack the resources and expert help as key problems with the ISO14001 implementation, with only 7% of the total SME population expressing an interest in the future adoption and implementation of the ISO 14001 standard. In contrast, larger and more experienced firms are seen to be more likely to achieve effective EMS implementation and to realize long-term benefits from ISO 14001 certification (Padma et al., 2008; Martín-Peña et al., 2014). Consequently, ‘resource availability’ and ‘number of employees’ are chosen as independent/control variables for this study that could independently contribute to the extent of waste minimisation efforts in firms. The unit of measurement for the variable ‘resource availability’ in our study is companies’ turnover on sales (per annum).

Business abroad
Experiences from different developing countries show that large companies trading internationally are more likely to be ISO 14001 certified (Christmann and Taylor, 2001; Zeng et al., 2009; Montiel and Husted, 2009; and Blackman and Guerrero, 2012). The stronger interest in EMS uptake among export-orientated firms Qi et al. (2011) attribute in part to certification pressures applied by customers, especially in western markets (To and Lee, 2014), as well as to firms’ desire to signal good environmental practices (see also Heras-Saizarbitoria, Molina-Azorín, Dick, 2011). International exposure will thus also be tested in this study in connection with SMEs. The ‘business abroad variable’ will be used to investigate whether trading internationally leads to improved environmental performance (waste minimisation) among SMEs.

Number of environmental options
Melnyk et al.’s (2003) study of Finnish SMEs examined the extent to which ISO certified firms considered various environmental options, showing that EMS certification had a significant and positive impact on waste management practices among certified firms. Certified firms were found to consider a wider range of environmental practices when compared with their non-certified counterparts. Similarly, Johnstone and Labonne (2009) identified certified manufacturing facilities in seven OECD countries as being more environmentally proactive (a factor also believed to be linked to ISO certification and firms’
financial performance (Llach et al., 2013)) and to employ a greater variety of environmental management tools. The US-based study by Florida and Davison (2001) also revealed that ISO 14001-certified firms had implemented other voluntary environmental tools to a greater extent than firms without an EMS. Analogously, in this study we examine whether the number of environmental options taken up by SMEs affects the extent of waste minimisation by firms. The inclusion of this variable will help build a more robust regression model to explore the influence of ISO-14001 certification of SMEs on waste minimisation. Figure 1 below details the environmental options adopted by SMEs in both Delhi and Noida.

Place Figure 1: Environmental options chosen by SMEs (shown as a percentage)

The following research hypotheses are drawn to be tested to separate the influence of the covariates on the relationship between the ISO 14001 status of SMEs and their degree of waste minimisation.

**H1:** There is a significant relationship between “ISO 14001 Status” of SMEs and the degree of Waste Minimisation when five other covariates are controlled in the relationship.

**H2:** There is a significant relationship between “ISO 14001 Status” of SMEs and the degree of Waste Minimisation when influence of five other covariates is considered in the relationship.

### 3.2 Methods

This paper is based on analysis of data derived from SMEs operating in the cities of Delhi and Noida. Companies were identified through the Sunrise Consultancy Services database (see www.fundoodata.com) for which an online subscription was obtained for a period of six months (15 February - 15 August 2013). Database access meant that the names of all registered businesses from the two regions as well as the contact details of company key personnel could be obtained.

Companies were surveyed by way of structured questionnaires. The survey comprised close-ended questions to measure the independent and control variables, state of EMS; number of employees; resource availability (in terms of annual turnover on sales); nature of business; international business (referred as business abroad); and number of environmental options available in companies. The survey also included questions to measure the dependent variable, extent of waste reduction in Indian SMEs. All responses were recorded along 5-Point Likert Scales.

The methods employed for the purposes of this study build on best practice recommendations derived from the literature. Specifically, the research audits waste generation in companies as opposed to environmental impacts (Natu, 1999) targeting specific aspects with potentially wide-reaching environmental impact (Seiffert, 2008). The work is aligned with the audit methodology employed by van Berkel (2004), originally developed to investigate the applicability of waste minimisation in developing countries (van Berkel, 1996). For the Indian MSME context we focused on eight generic practices, good housekeeping, input material change, better process control, equipment modification, technology change, onsite recovery and reuse, production of useful by product and product modification. The survey measured company performance against these practices using a total of 48 questions. The
The reliability of the instrument was checked with the Conbrach’s alpha score of 0.938. A common factor analysis using principal axis factoring was conducted using Varimax rotation. Kaiser-Meyer-Oklin as a measure of sampling adequacy was 0.556, which is moderate to good. Bartlett's Test of Sphericity (2975.735 at p=0.000) confirms the validity of the choice to consider all 48 items in the scale. The reliability and validity tests confirm the usefulness of the questionnaire in the context of Indian SMEs for similar studies.

The population of the study was determined with reference to the total number of SMEs with a turnover of equal or more than 1 Crore INR (~US$ 166,666) operating in the two cities. According to Fundoodata.com there are 150 SMEs operating in Noida and 390 SMEs in New Delhi meeting the study criteria. Approximately 400 SMEs were selected randomly, and questionnaires were sent off (by mail and/or personal delivery) to be completed either by senior management, key environment officers or resource allocators. There were two e-mail follow-ups for all 400 SMEs following the survey mail-out. Prior to survey administration, the survey tool was piloted involving four SMEs (both certified and non-certified) to test the questionnaire design. Pilot data are not reported on in this paper.

Of the 400 companies invited to participate in this study a total of 63 firms responded with 24 companies from Noida and 39 companies from Delhi. Out of the 63 companies 31 (49.2%) are manufacturers and 32 (50.8%) are service providers. CEOs, General Managers, Environmental manager, Manager-operations, Manager-quality assurance, Manager-HR are among the respondents. Manufacturers of Auto-component, Electrical and electronics goods, Steel Pipes, leather, Lighting products, textile, pesticides, plastics and chemicals are among the responding manufacturing companies whereas IT product sellers and solution providers, TV, studio, 3d animation, hotel and hospitality and medical related companies are among the respondents that are service providers. A total of 12 (19%) are ISO 14001 certified whereas 51 (81%) are not ISO 14001 certified. For the purpose of analysis the ‘resource availability’ category was divided into three groups along turnover figures. There are 18 (28.6%) SMEs with an annual turnover of 1-5 Crores, 22 (34.9%) with 5-10 Crores and 23 (36.5%) with above 10 Crores.

The survey comprised a total of 48 self-structured questions to measure the extent of waste reduction in Indian SMEs, and responses were recorded along 5-Point Likert Scales. The reliability of the instrument was checked with the Conbrach’s alpha score of 0.938. A common factor analysis using principal axis factoring was conducted using Varimax rotation. Kaiser-Meyer-Oklin as a measure of sampling adequacy was 0.556, which is moderate to good. Bartlett's Test of Sphericity (2975.735 at p=0.000) confirms the validity of the choice to consider all 48 items in the scale.

For the purposes of this study waste minimisation was taken as an environment aspect to measure SMEs’ environmental performance. In line with Seiffert (2008, 1455), this study considered a range of environmental practices for the measurement of waste minimisation, including reduction at source and reuse of the products as well as quality improvements and recycling (OECD workshop, 1996; EEA, 2002). Moreover, it is assumed in this study that EMS adoption will improve waste minimisation in medium–sized enterprises when compared to medium–sized enterprises without an EMS. The critical factors (see Singh et al. 2014) listed below are treated as independent variables in this study:

- EMS status (X1),
- Nature of business (X2),
• resource availability (X3),
• number of employees (X4),
• business abroad (X5); and
• number of environmental options (X6).

A research model (see Figure 2) has been put forth drawing on the independent and dependent variables identified in the literature to be tested, targeting SMEs with a turnover on sales over 1 Crore INR from the two Indian cities of Delhi and Noida. The model shows the relationship between the theoretical constructs and the variables. Hypotheses testing will reveal whether there is a significant positive relationship between ISO certification and waste minimisation in SMEs when all other related factors that may significantly influence this relationship are kept constant.

Place Figure 2: Proposed research model

4. Study results
The results are analysed based on a response rate of 16% (63 out of 400 firms). Several individual tests were conducted to verify that the variables satisfy the assumptions of multiple regression data analysis; firstly, the test for normality, linearity and homogeneity and secondly, significant correlation among dependent and independent variables in the model developed for the regression analysis.

4.1 Assumptions testing
Univariate normality was tested for the dependent variable (waste minimisation). Table 2 shows the calculation of the Shapiro-Wilk statistic (for sample<100). The significance level was greater than 0.05 (p>0.05), and so a normal distribution in the sample, drawn to measure the degree of waste minimisation, was assumed.

Place Table 2: Tests of Normality

Correlational measures of association are explained by Linearity. It is important to find out the non-linearity that may affect the correlation as it may not correctly estimate the actual significance or strength of the relationship. The assumption of linearity was checked by running a simple regression to examine the residuals for any probable non-linear portions in the scattered partial regression plots. A shown in the scattered plots in Figure 3, no non-linear element was detected.

Place Figure 3: Test for Linearity

As argued by Hair et al. (2010, 74) “homoscedasticity is desirable because the variance of the dependent variable being explained in the dependence relationship should not be concentrated in only a limited range of the independent variables”. This study thus allowed for a ‘fair test’ of the relationship across all values of the non-metric variables (all six independent variables and co-variables in this study).

Independent sample t-tests were conducted through the Levene test for equality of variances in SPSS to test this assumption. The Levene test results shown in Table 3 confirm the homoscedasticity (i.e., the spread of the degree of waste minimisation among each groups of the independent variable (X1) and co-variables (X2, X3,…X6)). A posthoc analysis
confirmed homogeneity, while showing significant improvement in WM when 5 or more environmental options were adopted by SMEs.

**Place Table 3: Test for Homoscedasticity**

Simple bivariate correlation, or zero order correlation, was run to measure the linear relationship. The Karl Pearson’s coefficient of correlation (r) has a range of possible values from -1 to +1. The value of r indicates the strength, and the sign indicates the direction of the relationship (Coakes, Steed and Price, 2008, 58). The Karl Pearson’s coefficient assumes that a large number of independent causes are operating in both variables so as to produce a normal distribution (Kothari, 2004,139). The correlation matrix in Table 4 shows the scores of the independent variables that are associated with scores of dependent variable (WM). The matrix shows a strong relationship between variables X3 and X4, creating a problem of multicollinearity, which may distort the value of regression coefficients. To reduce this problem, after a stepwise multiple regression with all six independent variables, we kept open the option of removing one of these two independent variables after testing their significance in the study through a confirmatory regression analysis and to remodel the regression equation.

**Place Table 4: Correlations**

4.2 Multiple regression analysis

**Stepwise regression-I (to test proposed model fit)**

Looking at the significant differences across the groups, X3 was first entered into the model. A high correlation was found between X3 (Resource availability) and X4 (No. of employees) with a 1-tailed Pearson’s correlation coefficient of 0.609 at .01 significance level (see Table 4). We entered X4 to examine its probable impact on the $R^2$ change. When X4 was entered, the adjusted $R^2$ valueas shown in Table 5 was both lower (0.073) and more significant ($p=0.011<0.05$) when compared to Model-1 in the regression. Due to high multicollinearity, the Beta score for X3 and X4 was evaluated. X3 was kept with a higher beta score (0.227) and entered into Model-2 along with X4 (beta score is 0.130). As shown in Table 7, the variance in WM was not significant for X4 when both X3 and X4 were entered in the regression. It was on that basis that X4 was removed from the model.

Table 6 explains significant differences among the groups in all the independent and covariables. When all the six variables were entered as in the proposed model, as shown in Table 5, the overall model fit explained 36.3% variance in waste minimisation due to the six independent variables at0.017 significance level showing a good model fit. Figure 4 explains normality, linearity and homoscedasticity of residuals. Also, Table 5 shows that the F change (1.55) value of 6.081 is greater than the critical table value (4.28) and thus significant at .05 level of significance.

In the proposed regression equation, X6 and X2 were found to be highly influential in variance in degree of waste minimisation. Notwithstanding, an alternative model was proposed (see Figure 5) for the following reasons:
1. Despite a good model fit, a low ‘adjusted $R^2$’ resulted when X3 and X4 were entered together, confirming high multicollinearity among these two variables, which may cause the distortion of results.

2. The impact of X1 (ISO 14001 Certification status) on the degree of waste minimisation could not be determined in context with the five other covariates (X2, X3, ... X6) in the study. The result of the t-test for X1 was insignificant (p=0.073>0.05) and thus showed no significant impact on WM. This was also the case for other variables (X3, X4, and X5).

Stepwise regression-II (to test alternative model fit)

Table 8 shows that F change (1,56) value of 6.185 is greater than the critical table value of 4.28 and thus significant at .05 level of significance.

The alternative regression model (see Figure 5) was designed with five factors, while omitting X4. Table 9 explains significant differences among the groups in all the independent and covariables in this model. When only 5 variables were entered in the model the overall model fit explained 36.3% variance in waste minimisation due to the five independent variables a .016 significance level. The significance level improved by 0.001 (see Model-5 in Table 8) while the variance in waste minimisation remained the same. As both the proposed and the alternative model explain the same level of variance there is a clear indication that X4 is a non-contributing factor. As such, the deletion of X4 had no impact on the overall $R^2$ result in the regression analysis. Figure 6 explains the assumptions for the residuals in regression.

4.3 Hypothesis testing
The testing of the proposed model led us to delete one non-significant variable (X4) from the regression equation (see Figure 4), and Hypotheses H1 and H2 were revised accordingly.

**H1**: There is a significant relationship between “ISO 14001 Status” of SMEs and the degree of waste minimisation when four other covariates are controlled in the relationship.

**H10**: The difference of variance in WM due to ISO 14001 certification is Zero, H10: $\beta_1 = 0$

**H1a**: There is a difference in variance in WM due to ISO 14001 certification, H1a: $\beta_1 \neq 0$

$\beta_1$ (partial correlation coefficient of X1) = (-0.416) ≠ Zero ($\beta_1$ is calculated after removing the variance of other predictors that are common with the main predictor X1)

The alternative hypothesis (H1a) is accepted.

*The Relationship between isolated X1 (0-Certified and 1-uncertified) and WM:*

Waste minimisation is 0.42 points higher in ISO 14001 certified companies than in uncertified companies.

$Y = \beta_0 + \beta_1 X_1$ [where, $\beta_1$ is the Zero-order correlation coefficient]

$WM = 208.981 + (-0.42) (0) = 208.981$ for ISO 14001 certified SMEs

$WM = 208.981 + (-0.42) (1) = 208.561$ for uncertified SMEs

**H2**: There is a significant relationship between “ISO 14001 status” of SMEs and the degree of waste minimisation when the influence of four other covariates is considered in the relationship.

**H20**: The difference of variance in WM due to all five(X1,X2, … X5) independent variables is zero, H20: $\beta_1 = \beta_2 = \beta_3 = \beta_5 = \beta_6 = 0$

**H2a**: There is a difference in variance in WM due to at least one out of five (X1,X2,…X5) independent variables, H2a: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_5 \neq \beta_6 \neq 0$

$\beta_1 = -0.237$ (p=.05, thus, there is a significant variance in the relationship)

$\beta_2 = -0.311$ (p=.02<.05, thus, there is a significant variance in the relationship)

$\beta_3 = -0.030$ (p=.82>.05, thus no significant variance in the relationship)

$\beta_5 = -0.126$ (p=.35>.05, thus no significant variance in the relationship)

$\beta_6 = 0.228$ (p=.04<.05, thus, there is a significant variance in the relationship)

The alternative hypothesis (H2a) can be accepted, if variance in WM due to any one variable is not equal to zero. We have only one variable $\beta_3$ which is close to zero (0.030), and all remaining variables are either less or greater than zero. $\beta_1$ (correlation coefficient of X1) = (-0.237) where, p=0.05, the alternative hypothesis (H2a) is marginally accepted.

*The Relationship between X1 (0-Certified and 1-uncertified) inclusive of the effect of other potential predictors of waste minimisation and WM:*

Waste minimisation is 0.24 points higher in ISO 14001 certified companies than in uncertified companies.
\[ Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_5 X_5 + \beta_6 X_6 \]  
where, \( \beta_1, \beta_2, \beta_3, \beta_5, \beta_6 \) are the Partial correlation coefficient

\[ WM = 208.981 + (-0.24) (0) + (-0.32) X_2 + (0.03) X_3 + (-0.126) X_5 + (0.228) X_6 \]

for ISO 14001 certified SMEs

\[ WM = 208.981 + (-0.24) (1) + (-0.32) X_2 + (0.03) X_3 + (-0.126) X_5 + (0.228) X_6 \]

for uncertified SMEs

The coefficients in Table 10 confirm that the ISO 14001 certification status of SMEs alone leads to waste minimisation as well as when considered with 4 other covariates. This result was confirmed also by the ANOVA test with WM as dependent and ISO 14001 status (X1) as the independent variable and by entering X2,X3, X5 and X6 as covariates in the analysis of variance.

Significant F-change (p=0.016<0.05) confirmed a significant degree of variance in waste minimisation due to all the factors considered in the model including X1.

Two of the hypotheses are accepted with a good alternative model fit. The stepwise regression results for the alternative model are analyzed below:

1. The Beta score in Model-3 (see Table 10) for X1 was -0.286 when entered with X3 and X5, the silent predictors of waste minimisation in this model. The t-value (-2.270) for X1 indicated greater variance among certifiers and non-certifiers. This suggests that for every unit increase in uncertified SMEs, there will be 0.286 point decrease in waste minimisation. Because the ‘state of ISO 14001’ was coded 0/1[0= certified, 1= not certified], it can be predicted that waste minimisation would be 0.29 points lower in non-certified companies. In Model-3, the ‘partial correlation coefficient’ for X1 ‘state of ISO 14001’ was recorded at -0.286 and did not change. This explains the sole (without any overlap of influences from other covariates) effect of ‘state of ISO 14001 (X1)’ on waste minimisation when the effects of two other covariates are either kept constant or are eliminated. Except X1, neither X3 nor X5 were significantly influencing WM in this model after X1 was entered into the regression analysis. X3 and X5 in this analysis are referred to as silent predictors of WM.

2. The Beta score in Model-4 (see Table 10) for X1 was -0.278 when entered with X3, X5 and X6, the silent predictors of waste minimisation in this model. The t-value was reduced (-2.255) for X1, indicating a variance in WM between certifiers and non-certifiers. It can be interpreted that for every unit increase in uncertified SMEs, there will be 0.278 point decrease in waste minimisation. Because the ‘state of ISO 14001’ is coded 0/1[0= certified, 1= not certified], the predicted waste minimisation would be 0.28 points (.01 less than in Model-3) lower in SMEs that are not certified. In Model-4, the ‘partial correlation coefficient’ for X1 ‘state of ISO 14001’ was -0.286 (same as compared to Model-3). This explains the sole effect of ‘state of ISO 14001 (X1)’ on waste minimisation when the effects of three other covariates are kept constant or are eliminated. Variables X3, X5 and X6 (except X1) did not significantly influence WM when X6 was entered to the regression analysis.

3. The Beta score in Model-5 (see Table 10) for X1 was -0.237 when entered with X3, X5,X6, the silent predictors of waste minimisation, and X2 in this model. The t-value was further reduced (-1.985) for X1, indicating variance in WM among certifiers and non-certifiers. This suggests that for every unit increase in uncertified SMEs, there will be 0.237 point decrease in waste minimisation. Because the ‘state of ISO 14001’ is coded
0/1[0= certified, 1= not certified], the predicted waste minimisation would be 0.24 points (0.04 less than in Model-4) lower in SMEs that are not certified. In Model-5, the ‘partial correlation coefficient’ for X1 ‘state of ISO 14001’ is -0.256 (0.03 points lower as compared to Model-4). This explains the sole effect of ‘state of ISO 14001 (X1)’ on waste minimisation in a condition where the effects of four other covariates were kept constant or were eliminated. Variables X3, X5 and X6 (except X1 and X2) did not significantly influence WM when X2 was entered into the regression analysis.

5. Discussion

The study discussed in this paper included both certified and non-certified companies to test empirically the impact of ISO 14001 certification on the environmental performance of SMEs. As suggested previously, this issue has been raised by numerous studies but to this day produced only limited and conflicting empirical data. In this paper, waste minimisation was used as a tangible measure of environmental performance, including all probable forms of waste (solid, liquid and gaseous) that could be generated in SMEs. This helped reduce the problem of time and resource requirements in conducting waste audits or getting access to the audit results. The analytical tools described in this paper lend themselves to be applied to similar research problems in future studies. The use of Beta scores, which were analysed to understand the relationship between the different variables under investigation, has the advantage of eliminating the problem of dealing with different units of measurement in any of the variables. The use of standardized data with a common unit of measurement allowed for the identification of the independent variables with the most impact (see Hair et al., 2010, 199).

The findings in this study point to the partial effect of ‘state of EMS in SMEs (X1)’ on waste minimisation efforts in SMEs. This was significant ($\beta=0.256$) (see Table 10) when the regression coefficient ($\beta$) was standardized to 1. The data showed that ISO 14001 certification was responsible for a 25% variance in waste minimisation efforts between certified and uncertified firms. The Zero-order correlation coefficient (-0.416) was even higher when the influence of other covariates was ignored. In expounding, a variance of 42% could be found in the waste minimisation efforts between certified and uncertified companies, which was the result of ISO 14001 certification as well as two other factors, namely ‘nature of business’ (X2) and ‘number of environmental options’ (X6). Thus, this study helps substantiate arguments for the positive role of ISO 14001 certification in SMEs in India. The findings also highlight the impact of the two covariates ‘nature of business’ (X2) and ‘number of environmental options’ (X6). Both were found to have strong partial effects on the degree of waste minimisation, meaning that manufacturing SMEs and those with a large number of environmental options are likely to be successful in achieving waste reductions. The fact that manufacturers were found to be more likely waste minimisers may be related to the fact that they are generators of all kinds of wastes but at the same time underneath the radar of the pollution boards. Manufacturing Indian SMEs may therefore use ISO 14001 certification as a ‘signalling device for performance’ to environmental stakeholders such as international customers, which was found to be underlying the early adoption (Heras-Saizarbitoria, Molina-Azorín, Dick, 2011) and diffusion of ISO 14001(Qi et al., 2011, 1255). As mentioned earlier, ISO uptake among manufacturing SMEs may also be driven by a sector-specific certification culture, as ISO 14001 penetrations is generally greater in manufacturing (Johnstone and Labonne, 2009, 728; Qi et al, 2011; Zobel, 2013).
To better understand the environmental efficacy of ISO 14001 certification further targeted research is needed, focusing specifically on SMEs’ environmental management performance, which to this day – even among firms with EMS uptake – is rarely found to be effective (Ferenhof et al., 2014). Nowrocka and Parker (2009) in this regard suggest a more nuanced treatment of EMSs and improvements in environmental performance to facilitate the identification of the factors influencing firms’ environmental performance and the strengthening of mechanisms to further improve it. The study by Jabbour et al. (2013) arguably answered to some extent why ISO 14001 (as one variable for environmental management) leads to better environmental performance. Their work revealed a highly significant relationship between ISO 14001 and lean manufacturing, suggesting that lean manufacturing helps improve environmental management and in turn improves operational performance. Future studies may thus focus on the question of ‘how’ EMS helps improve environmental performance (Nowrocka and Parker, 2009). However, critical to such research efforts – as suggested by Hussey and Eagan (2007) – is a shared understanding of the meaning of good environmental performance. For the last 10 years there have been growing calls in the literature for the development and use of standardized environmental indicators as a means of gauging firms’ performance and EMS efficacy of SMEs; a need arguably reflected in the release of the ISO 14031:2013 and ISO 14005:2010 standards, which offer guidance on the design and use of environmental performance evaluation and the integration and use of environmental performance evaluation techniques respectively. While there is cause for caution concerning the design of environmental indicators due to the uncertainty factor that can affect their accuracy and meaningfulness (see Perotto et al., 2008), the use of indicators is widely welcomed for they are seen to offer firms benchmarking opportunities and a basis for comparison of environmental performance as well as assist SMEs in tracking their environmental management performance even in the absence of a formalized EMS (see Jash, 2000; Rao et al., 2006). The adoption of a life-cycle perspective in this regard can complement indicator design and provide more detailed insights into the environmental performance of SMEs (see Muñoz et al., 2013; Zhang et al., 2014).

Notwithstanding concerns about EMS efficacy, the data presented in this paper speak to the role of ISO 14001 certification in reducing waste generation in Indian SMEs, and as such offer clues to policy makers for advancing the environmental agenda in the country’s SME sector. It was shown earlier that industrial waste generated by SMEs in India is posing a serious and growing threat to human and environmental health. India has a rich history of environmental policy-making, yet environmental regulation has thus far been unable to arrest the rate of environmental deterioration in the country (Dasgupta, 2000). While there are good grounds for tighter direct environmental regulation and improved enforcement (Misra and Pandey, 2005; Greenstone and Hanna, 2011; Wath et al., 2011), an ongoing policy focus on voluntary ISO certification may also be well justified. Since 2002, the Indian government has been encouraging the uptake of ISO 9000 and 14001 among small-scale sector enterprises. The government scheme offers the reimbursement of the cost of acquiring ISO-9000/ISO-14001/HACCP certifications to the extent of 75% of the expenditure subject to a maximum of Rs. 75 000 (~ $US1370). The outcomes of this scheme are not known and have not been analyzed systematically as part of the country’s five-year plans. Certification data would suggest, however, that the scheme has traction even though ISO 14001 uptake in India is still much slower than in countries such as China and Thailand (ISO, 2011). Indian government data (DCSME, 2009, 20) for the 2006-07 survey period suggest that 13602 ISO 14001 certificates were obtained by SMEs with 9323 certifications being ISO 14001 certifications and 4279 certificates being for both ISO 14001 and ISO 9000. As the cost associated with formal ISO 14001 uptake is a known key a barrier to certification among SMEs (see Petts
2000; Rao et al., 2006), EMS alternatives with comparatively lower adoption and implementation cost may well be worthy of consideration in this regard for they could help accelerate environmental improvements in the small-scale business sector (Heras and Arana 2010; Campos, 2012; Granly and Welo, 2014). At the same time, however, such alternatives do require strong environmental rules and regulations to ensure that environmentally meaningful outcomes are achieved, and effective environmental policy-making and enforcement cannot be assumed in developing country contexts. In this sense, the contextual fit of alternative EMS models would also need to be considered.

Overall, the data presented in this paper, which reflect the findings from the international literature (e.g. Steger, 2000; Melnyk et al., 2003; Hillary, 2004; Potoski and Prakash, 2005; Khanna, 2010b; Oliveira et al., 2010; Zorpas, 2010; Franchetti, 2011; Comoglio and Botta, 2012; Massoud et al., 2012; Martín-Peña et al. 2014; Testa et al., 2014; Nguyen and Hens, in print), lend support to government initiatives aimed at improving waste management in industry by way of encouraging ISO 14001 certification. However, as the data were derived from a two-city study only, further work is needed to test empirically the relationship between firms’ ISO certification status and their environmental management performance. The model used and tested in this paper may provide the basis for such work.

6. Conclusions
The study reported on in this paper sought to test the relationship between SMEs’ ISO 14001 status and the degree of waste minimisation found within those firms. This relationship was tested while a) controlling the influence of critical factors (H1) and b) considering the effect of critical factors (H2). The study was conducted involving both ISO 14001 certified and uncertified SMEs.

The findings suggested that ISO 14001 certification alone helped account for a 25% reduction in waste among certified companies. The variance between certified and uncertified firms rose to 42% when other critical factors were considered. Key factors were ‘nature of business’ and the ‘number of environmental options’ available to firms. Overall, manufacturers and firms with a large number of environmental options were found to be more successful waste minimisers.

We acknowledge that the low response rate of 16% (63 out of 400 firms) is a key limitation of this study, critically affecting the generalisability of its results, which thus need to be seen as indicative only. Further, similar to most research undertaken to date in the EMS field, this study has also been quantitative in nature and consequently been unable to delve deeper into the integration of the ISO standard in SMEs and potentially reflected only the dominant in-house biases of the SME managers who have responded to the survey (Borial, 2007). Relatively, the study neither lends itself to imputations on the motivations underlying the uptake of ISO 14001 certification among SMEs (Bansal and Roth, 2000) nor an assessment of the extent to which ISO 14001 certification has been internalised (Qi et al., 2012). As identified in a series of studies (e.g. Fryxell et al., 2004; Gavronski et al., 2013; King et al., 2005), firms’ motivations for ISO 14001 affect their environmental management performance. Companies may well adopt ISO 14001 as a means of merely signalling good environmental practices to market while in real terms their environmental performance may indeed be lower than that of their peers (e.g. Bansal and Hunter, 2003). While work in this area is starting to emerge (e.g. Singh et al., 2015) issues such as these require further investigation in the Indian context.
The model employed in this study and the data overall provide nonetheless a good basis for future research on EMS effectiveness in SMEs. The results point to the efficacy of ISO 14001 certifications it relates to waste minimisation and mirror the results of comparable studies (e.g. Franchetti, 2011; Montabon et al., 2000; Melnyk, 2002; Nguyen and Hens, in print; Potoski and Prakash, 2013; Zhang et al., 2014) that also show a significant decrease in waste generation consequent to ISO 14001 certification. In this regard, government efforts seeking to drive the voluntary uptake of ISO 14001 certification among Indian SMEs play a vital role in improving firms’ waste performance and may indeed, as suggested by To and Lee (2014), help bolster the international competitiveness of export-orientated SMEs. As such, the ongoing – albeit slow – diffusion of the ISO 14001 standard among Indian SMEs helps drive waste minimization and may indeed contribute to an overall reduction in environmental impacts of the country’s small-scale sector. Yet, as suggested earlier, the overall environmental effectiveness of ISO 14001 in SMEs is yet to be established.

While this study offers critical insights into the Indian certification environment, further research is needed to fully understand the status and impact of ISO 14001 certification in India, requiring both qualitative and quantitative work. Future research may then also focus on the aforementioned issue of E-waste generation by service SMEs and test the significance and usefulness of EMS-ISO-14001 in this context.

References


Khanna, V.K., 2010a. EMS and its effectiveness in Indian organizations. IEEE Xplore.


Table 1: India’s most polluting industries (Central Pollution Control Board, 2014)

<table>
<thead>
<tr>
<th>Industries</th>
<th>Industries</th>
<th>Industries</th>
</tr>
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<td>Aluminium Smelters</td>
<td>Fertiliser Plants</td>
<td>Pulp &amp; Paper</td>
</tr>
<tr>
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<td>Integrated Iron &amp; Steel</td>
<td>Oil Refineries</td>
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<td>Copper Smelters</td>
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<td>Distilleries</td>
<td>Petrochemicals</td>
<td>Zinc Smelters</td>
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Table 2: Tests of Normality

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a. Lilliefors Significance Correction
### Table- 3: Test for Homoscedasticity

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<td>Business abroad (X5) - Covariable</td>
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<td>Number of environmental options (X6) - Covariable</td>
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Table 4: Correlations

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**. Correlation is significant at the 0.01 level (1-tailed).

*. Correlation is significant at the 0.05 level (1-tailed).
## Table 5: Model summary

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c. Predictors: (Constant), X3, X4, X5  
d. Predictors: (Constant), X3, X4, X5, X1  
e. Predictors: (Constant), X3, X4, X5, X1, X6  
f. Predictors: (Constant), X3, X4, X5, X1, X6, X2  
g. Dependent Variable: WM
## Table 6: ANOVA results

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* Predictors: (Constant), X3, X4, X5
* Predictors: (Constant), X3, X4, X5, X1
* Predictors: (Constant), X3, X4, X5, X1, X6
* Predictors: (Constant), X3, X4, X5, X1, X6, X2
* Dependent Variable: WM
### Table 7: Coefficients\(^a\)

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\(^a\) Dependent Variable: WM
Table 8: Model summary

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c. Predictors: (Constant), X3,X5,X1
d. Predictors: (Constant), X3,X5,X1,X6
e. Predictors: (Constant), X3,X5,X1,X6,X2
f. Dependent Variable: WM_Total
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b. Predictors: (Constant), X3,X5
c. Predictors: (Constant), X3,X5,X1
d. Predictors: (Constant), X3,X5,X1,X6
e. Predictors: (Constant), X3,X5,X1,X6,X2
f. Dependent Variable: WM_Total
Table 10: Coefficients\(^a\)

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\(^a\) Dependent Variable: WM_Total
Figure 1: Environmental options chosen by SMEs (shown as a percentage)

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Figure 2: Proposed research model

ISO-14001 Status (Certified/uncertified) (X1)

Nature of Business (X2)

Annual Turnover (X3)

No. of Employees (X4)

Business Abroad (X5)

No. of Env. Options (X6)

Hyp H1 & H2

Waste Minimisation (WM)

Independent Variables X2, X6 are covariates of X1 and controlled to test Hypotheses H1 and H2

Y (WM) = β0 + β1X1 + β2X2 + β3X3 + β4X4 + β5X5 + β6X6
Figure 3: Test for Linearity

Scatterplot

Dependent Variable: WM_Total

Partial Regression Plot

Dependent Variable: WM_Total

12. No. of Employees

13a. Is your company venturing outside India?

11. Total Annual Turnover on Sales of your Company: Rs.
Figure 4: Normality, linearity and homoscedasticity of residuals

**Normality for residuals**

Histogram

Dependent Variable: WM_Total

**Linearity**

Normal P-P Plot of Regression Standardized Residual

Dependent Variable: WM_Total

**Homoscedasticity**

Scatterplot

Dependent Variable: WM_Total
Figure 5: Alternative model for regression analysis (X4 excluded)

Independent Variables X2, X3, X5 and X6 are covariates of X1 and controlled to test Hypotheses H1 and H2.
Figure 6: Normality, linearity and homoscedasticity of residuals

**Normality for residuals**

Histogram

**Linearity**

Normal P-P Plot of Regression Standardized Residual

**Homoscedasticity**

Scatterplot
The relationship between the ISO 14001 status and waste minimisation in Indian SMEs is assessed.

Differences in waste minimisation between ISO 14001 certified and non-certified SMEs are examined.

A positive relationship between ISO 14001 certification and waste minimization in SMEs is confirmed.

The findings are robust when four other influencing co-variables are controlled.

Manufacturers and firms with more environmental options are found to be significant waste minimisers.