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Modeling the Drivers of Eco-Innovation Adoption within Iranian Manufacturing Small and Medium-Sized Enterprises

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Abstract There are various studies on the eco-innovation in the literature, but there is a scarcity of studies on the adoption and diffusion within manufacturing small and medium-size enterprises (SMEs). Drivers to adopt eco-innovations by manufacturing SMEs are required to be understood properly and be analyzed regarding the relationships among them. Hence, the purpose of this study is to identify the main drivers of eco-innovation adoption by Iranian manufacturing SMEs from the literature and further model them based on experts' opinions. We have utilized the valuable opinions of experts to develop a hierarchical model of drivers utilizing Interpretive Structural Modeling approach to demonstrate the contextual interrelationship among these factors. Furthermore, degrees of relationships among the drivers were obtained according to Matrice d'Impacts Croises Multipication Applique´ an Classment analysis approach. Identification and modeling of eco-innovation drivers is expected to assist managers of companies to develop policies and further prioritize them to facilitate eco-innovation adoption.

Keyword: Eco-Innovation, Small And Medium-Sized Enterprises, Interpretive Structural Modeling, Adoption, Manufacturing.

1 Introduction

Being cognizant of efforts taken by industries to establish alternatives to mitigate environmental risks derived from their business activities [1], environmental sustainability and innovation became well-established concepts and should be well comprehended by business managers and policy makers [2]. Green products' innovation is an approach towards the integration of environmental sustainability and innovation which would positively impact companies' economic growth and society's quality of life [3]. Traditionally, environmental sustainability has been considered as an approach which belies the aims of businesses' growth, competitiveness, and profitability [4]. Linkage of innovation to ecology has been observed in recent years more and more often [5]. Managers' recognition to minimize the environmental impact of business activities defines the firm's environmental orientation [6].

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One approach that firms can apply to become greener is through the adoption of eco-innovation which is a "strategy for providing customer and business values that contributes to sustainable development and decreases environmental costs and impacts" [7].

Concerns regarding the adoption and diffusion of eco-innovation has been grown significantly among both academics and practitioners during the past two decades [5, 6, 8, 9]. Due to the importance of eco-innovation in developing sustainable nations, industries, and corporations [10, 11], identifying drivers and determinants of eco-innovation by corporations is a hot topic in the literature [8, 9]. A number of researchers from various disciplines such as innovation adoption, management, and environmental economics tried to investigate the drivers of eco-innovation from different perspectives [7]. In the innovation literature, factors related to technology push, market, and demand pull are highlighted as the most important determinants of eco-innovation adoption within organizations [12, 13]. Insights into corporate social responsibility (CSR) policies of firms are provided in management literature to motivate managers and decision-makers to invest more on eco-innovation and further reinforce or reorient their legitimacy-maintenance strategies [e.g., 14, 15, 16]. The iranrole of organizational capabilities, particularly environmental management systems (EMS), on eco-innovation adoption is stressed by other authors in management literature. The assumption is that, due to strong organizational capabilities of firms in environmental management, eco-innovation adoption and diffusion would be facilitated through the implementation of EMS such as ISO14001 or its European version, EMAS [e.g., 17, 18, 19]. Impact of environmental regulations (e.g., emission charges, standards, and permits) on eco-innovation adoption has been investigated in the literature related to environmental economics. Several recent studies reported regulatory pressures as one of the significant drivers of eco-innovation within corporations [e.g., 20, 21, 22].

Manufacturing companies are recognized as the main contributors of environmental degradation since industrial revolution [23]. There are strong evidences which show the situation is going to become worsen, and hence, there is a global call to take evasive actions to mitigate precipitating damage to the environment. Although, small and medium-sized enterprises (SMEs) are contributing significantly to the environmental degradation, most managers and business owners are not aware of their firms' adverse contribution [24-26], and few are acting towards reduction their impact [27]. The integration of innovation and sustainable development is a topic which needs further discussion and investigation in the current literature. In this area, adoption and diffusion of eco-innovations within manufacturing SMEs is still in its infancy [28]. Studies on eco-innovation and SMEs show that, the focus of majority of studies on innovation and SMEs are focused on other areas while limited ones investigated the drivers of eco-innovation adoption by manufacturing SMEs [e.g., 7, 8, 29, 30]. Generally, in SMEs context, the studies on innovation investigated other themes such as innovations within service SMEs [31], innovation capacities within SMEs [32], importance of trademarks [33] and governmental financial supports for innovations of regional SMEs [34]. Hence, according to the literature and the studies by Pacheco, ten Caten [28] and del Río, Peñasco [8] it is obvious that there is a scarcity of studies on eco-innovation in SMEs.

Although several studies investigated the drivers of eco-innovation adoption in companies, limited ones explored the context of manufacturing SMEs. The existing gaps in the current studies on eco-innovation in SMEs confirm the importance of our study. Klewitz and Hansen [35] confirm our claim and state that "[…] future research could try a more differentiated look at SMEs" while in their study they have not discern different types of SMEs. Triguero, Moreno-Mondéjar [19] suggest further investigation of eco-innovation drivers according to the type of SMEs. Accordingly, by considering the aforementioned gaps, this study tries to answer the following research questions:

- What are the main drivers of eco-innovation adoption within manufacturing SMEs?
- How is the contextual interrelationship among these drivers?

To answer these questions, we have obtained the main drivers of eco-innovation through most recent review articles on drivers of eco-innovation adoption by Pacheco, ten Caten [28], Bossle, de Barcellos [2], del Río, Peñasco [8] and Hojnik and Ruzzier [36]. Then, the contextual interrelationships among the drivers is analyzed utilizing the Interpretive Structural Modelling (ISM) approach and Matrice d'Impacts Croisés-Multiplication Appliquée á un Classement (MICMAC) analysis technique.

Following an increasing social and political awareness of ecological problems, concurrence with the recognition of innovation as an engine of economic growth, findings of this study led to accentuate environmental innovation or more recently eco-innovation as a key strategy which assist manufacturing SMEs to make their economic and environmental goals compatible and further transform their current patterns of their economic growth to a more sustainable one.

The organization of the paper is as follows. Section 2 presents the theoretical background of the study and further lists the identified drivers of eco-innovation adoption. Section 3 presents the research method of the study. Analyses and results of the study utilizing the introduced methods are presented in Section 4. Discussion on the results is presented in Section 5. Conclusions of the study, limitations, future studies and implications of the study are presented in Section 6.

2 Theoretical Background

2.1 Eco-innovation

Since there is no agreement on a common definition of eco-innovation in the literature, defining this concept is not a simple task. According to a research project named as “Measuring Eco-Innovation” funded by EU, eco-innovation is defined as “the production, application or exploitation of a good, service, production process, organizational structure, or management or business method that is novel to the firm or user and which results, throughout its life cycle, in a reduction of environmental risk, pollution and the negative impacts of resource use (including energy use) compared to relevant alternatives” [37]. Three important features are implied from this definition: (1) subjective view of innovation (the innovation should be new to the corporation), (2) implemented innovations are considered rather than hypothetical activities targeted at reducing environmental impacts, and (3) the state-of-the-art is related to the environmental impact. Another definition is proposed by Eco-Innovation Observatory [38] which states that eco-innovation is the “introduction of any new or significantly improved (good or service), process, organizational change or marketing solution that reduces the use of natural resources (including materials, energy, water and land) and decreases the release of harmful substances across the whole life-cycle.” In another definition, eco-innovation is defined as “product, process, marketing and organizational innovations, leading to a noticeable reduction in environmental burdens. Positive environmental effects can be explicit goals or side effects or innovations. They can occur within the respective companies or through customer use of products or services” [12]. While several definitions of eco-innovation exist in the literature with different wordings, environmental components are encompassed in all definitions and two main consequences of eco-innovations are reflected in them as: minimizing adverse effects on the environment and use of resources efficiently [36].

2.2 SMEs and eco-innovation

To be capable of remaining in the competitive market, SMEs are required to be innovative and sustainable regarding their business operations [35, 39]. Accordingly, to enhance their sustainability, SMEs are required to shift their focus from solely profit-oriented innovations towards the ones targeting the sustainability of environment and society [40]. It is claimed profitability and environmental sustainability of businesses can be boosted through eco-efficient and eco-effective practices [41]. However, eco-innovation practices happen less in SMEs rather than larger corporations due to their restrictions in their resources or influences on their supply chains. Achieving sustainability through eco-innovation practices is an appropriate approach and SMEs are advised to manage their resources to adopt these sustainability initiative to maintain the competitive edge [42]. In the literature, there is few evidences of studies reporting SMEs' utilization of eco-innovations to enhance their performance [27, 28]. In these studies, it was reported that they were responding to some external stimulations such as legislations [19, 28], involvement with non-governmental organizations [35], and/or cost [28, 43] among others. Research has reported that, SMEs who involved in low-risk eco-innovation practices are encouraged to take further actions towards business improvement which may result in radical innovations within their firms [27, 35].

Coping strategic issues within SMEs, such as adopting eco-innovations, that may influence their entire business process and value chain can be the complex ones [44]. According to Ates and Bititci [45], SMEs' business strategies are often emergent which means their strategies are fluctuating according their immediate demands of being competitive. While practicing eco-innovations make SMEs to be more flexible than larger corporations, SMEs' owners are usually dissuaded because of the emphasis on short-term perspectives, accordingly, required strategies are needed to be explicit rather than reactive in order to adopt eco-innovations successfully within such firms [27].

2.3 Drivers of eco-innovation adoption

To extract the determinants of eco-innovation adoption, we referred to most recent review articles on drivers of eco-innovation by Pacheco, ten Caten [28], del Río, Peñasco [8], Bossle, de Barcellos [2] and Hojnik and Ruzzier [36]. The results of these four studies have complemented each other and helped us to have a holistic view on the investigated eco-innovation adoption drivers in the literature. Table 1 exhibits the factors extracted from these sources.

Scholars highlighted regulations, which also is known as "regulatory push/pull (1) effect" [8, 46], as one of the most important determinants of eco-innovation adoption in several studies [19, 47, 48]. According to the study conducted by Popp [49] on the adoption of innovation within companies located in Japan, Germany and United States, the author found that national regulations was the main driver of companies' decisions. Likewise, in similar studies scholars reported that policy stringencies on environmental regulations has higher impact on companies to move towards environmental sustainability, and here eco-innovation adoption and diffusion [50, 51]. In the study conducted by Horbach, Rammer [12] on the firms' sustainability movements such as reducing air, water and noise emissions, avoiding hazardous substances and increasing recycling, they found environmental regulations as one of the main determinants. Following the previous studies conducted on the determinants of eco-innovation [e.g., 2, 19, 28], it can be concluded that regulatory push/pull plays an important role in motivating manufacturing SMEs to adopt eco-innovations.

Table 1 Determinants of eco-innovation adoption

NO.	Determinant	Pacheco, ten Caten [28]	del Río, Peñasco [8]	Hojnik and Ruzzier [36]	Bossle, de Barcellos [2]
1	Regulatory push/pull • Environmental regulations • Subsidies	✓	✓	✓	
2	Technology push factors • R&D • Cooperation & collaboration • Technological capabilities	✓	✓	✓	✓
3	Performance	✓		✓	✓
4	Market pull factors including: • Customer pressure • Cost saving • Improvement of company reputation/image • Increase in market share • Competitive advantage	✓	✓	✓	✓
5	Institutional isomorphisms • Coercive pressure • Mimetic pressure • Normative pressure			✓	✓
6	Environmental capabilities	✓			✓
7	Environmental leadership	✓			✓
8	Environmental culture			✓	
9	Corporate social responsibility/corporate environmental responsiveness			✓	
10	Managerial environment concerns			✓	
11	Top management support	✓	✓	✓	✓
12	Supplier involvement	✓		✓	
13	EMS		✓	✓	
14	Human resources • Training • Sustainability programs	✓		✓	✓
15	Public pressure/awareness			✓	

Technology push factors (2) are highlighted as the main determinants of innovation adoption in general innovation literature [52]. Since technological capabilities of a firm is emphasized in general innovation theory [53], these capabilities are achieved through "physical and knowledge capital of a firm to develop new products and processes" [13]. Accordingly, to gain such capital stock further education of a firm's employees or R&D investments are necessary. Given the complexities of eco-innovations, the importance of cooperation among different parties is also highlighted in the literature [36, 41, 54]. Corporations need to learn how to reengineer their business process to do their activities without harming the environment, hence, cooperation and interdependencies among the firms, universities, suppliers, distributors, and customers would increase the likelihood of eco-innovation adoption and development [52, 55, 56].

The ultimate reason in which companies adopt innovations is to enhance their performance (3) [57, 58], that can be achieved by increasing demands or reducing costs by developing and implementing more efficient process eco-innovations. While traditional economic views consider eco-innovation adoption as an external cost to the company which would lead to higher costs to use environmental technologies [59], recent studies consider eco-innovation adoption as a “win-win” situation by providing both financial and environmental benefits [58, 60-62]. Reducing or eliminating company’s waste or pollution would strengthen corporate competitiveness and provides immediate and long term performances to the firm [63].

Factors related to marketing literature which focuses on customers’ benefits [64] are found as important determinants of eco-innovation in relevant studies. These factors are known as market pull factors (4). Empirical studies show that customer benefits [64], enhancing the firm’s image [65], cost saving [12], competitive advantage [66] and increasing in the market share [19] which are considered as pull factors are influencing the adoption of eco-innovation within corporations [36].

Numerous studies have applied institutional theory in investigating the factors influencing the adoption of eco-innovations within corporations [58, 67, 68]. The theory suggests that organizational behaviors are formed by three institutional isomorphisms (5) [69]. First, coercive pressure refers to the “regulative pillar” which are occurred through those who are in power such as government agencies; accordingly, pressures imposed by institutions or environmental regulations are regarded as coercive pressures as well [70]. From the reviewed studies by Bossle, de Barcellos [2], regulatory pressures found as the predominant driver of eco-innovation adoption in the literature. Various studies showed that, pressures from regulatory stakeholders or stricter regulators would boost the adoption of eco-innovations and even stimulate organizations to establish R&D policies [7, 71]. Huang, Hu [72] showed that regulatory pressures significantly influence top management support of green innovations, the extent of training, R&D investment, adoption of EMS and further adoption of green innovations. Second refers to mimetic pressure which occurs when a company follows its competitors by mimicking their successful actions. Finally, pressures that force companies to adopt accreditations or certifications typically exerted by internal or external stakeholders refer to normative pressures. Forces exerted by international institutions have greater influences than domestic ones which usually are incorporated with proenvironmental practices such as the adoption of ISO 14001 [73].

Vision and long-term commitment are required to move an organization towards a sustainable one [74]. Chen and his colleagues [75] accentuated the importance of environmental/green capabilities (6) in determining proactive and reactive green innovation. Environmental capabilities of a firm is defined as to “integrate, coordinate, build, and reconfigure its competences and resources to accomplish its environmental management and environmental innovations” [75]. In another study, Chen [65] refers to environmental capabilities as “green core competence” and defined it as “the collective learning and capabilities about green innovation and environmental management in an organization”, which found as another important determinant of green innovation adoption within organizations [76-78]. Environmental leadership (7) is also found as an important factor influencing the adoption of eco-innovation. It is defined as “a dynamic process in which one individual influences others to contribute to the achievement of environmental management and environmental innovations” [75]. Top managers’ environmental leadership can develop organizational beliefs towards environmental sustainability, which further can influence employees' behaviors to adopt eco-innovations [75, 79]. Together with environmental leadership and capabilities, Chen, Chang [75] reported the importance of a firm's culture on eco-innovation adoption. While there is no universally accepted definition of organizational culture in the literature, Chen, Chang [75] defines environmental culture (8) as "a symbolic context about environmental management and environmental innovations within which interpretations guide behaviors and processes of members' sensemaking". To motivate organizations to move towards eco-innovation adoption, full integration of social and environmental aspects of corporate sustainability into the firm's vision, culture and operations is needed [80].

Corporate social responsibility/corporate environmental (9) responsiveness reflects the extent to which organization responses to social and natural environmental issues. According to Rexhepi, Kurtishi [81], corporate social responsibility is an ethical framework that when follows correctly, enables corporations to utilize resources efficiently and further motivate them to adopt eco-innovations which finally benefits firms in long-term. Top management team of a firm plays a crucial role in determining eco-innovation adoption [82]. Managers can shape the norm of an organization which can foster creativity and innovation.

Managerial environmental concerns (10) towards the environment is positively related to responsiveness of a firm towards environmental issues and further fosters eco-innovation adoption by the corporation [83-86]. Managerial commitment and support in developing eco-friendly products is accentuated vastly in the literature. Katsikeas, Leonidou [87] defines top management support (11) in the context of eco-innovation adoption as "the extent of senior-level managerial commitment, support, and leadership in the pursuit of corporate environmental preservation and deployment of corporate environmental practices". Commitment and support of senior managers is a vital managerial resource within organizations which greatly determines the adoption and implementation of eco-friendly products and innovations within corporations [88-90].

In the literature, it is highlighted that purchased materials and components from suppliers greatly impact quality, development cycle, competitiveness, cost dependency and product design [7, 91, 92]. The eco-performance of a product is mainly determined by its upstream environmental impacts. Hence, many scholars highlighted the importance of monitoring/auditing/assessment of suppliers during the management of value chains [3, 91], and consequently, several guidelines are proposed to assist working in partnership with suppliers. Accordingly, supplier involvement (12) is also emphasized as an important determinant in motivating organizations to adopt eco-innovations [20, 36, 91, 93].

Another important determinant of eco-innovation adoption is EMS (13) which is considered as environmental organizational innovation [94]. Its importance in eco-process and eco-product innovations within firms is emphasized in the literature [12, 95, 96]. EMS is very important in motivating organizations to adopt cost-saving eco-innovations, because they help firms to overcome incomplete information. Another relevant determinant of eco-innovation adoption is human resources (14) [80]. By maintaining employees' capabilities, skills, knowledge and abilities, and at the same time by maintaining their satisfaction and motivation, possibility of adopting green innovations becomes higher [97, 98]. Public and social awareness and pressure have been found as significant predictors of eco-innovation. Lack of public awareness regarding environmental problems may act as a significant barrier to the adoption of eco-innovations which simply reflects the lack of interest in using eco-friendly products [99]. In the literature, it is highlighted that public awareness/pressure (15) is more important than regulatory pressures. Social environmental awareness and their pressure motivate firms to be more innovative in their environmental performances and move towards to use eco-innovations in their business activities [100, 101].

While several factors are mentioned as the determinants of eco-innovation adoption in the studies by Hojnik and Ruzzier [36] and Bossle, de Barcellos [2], variables with mixed and sometimes unknown results were not considered in this study. For example, there is an ambiguity in the literature regarding the effect of environmental policy on eco-innovation adoption [102], same logic goes for economic incentive instruments as well [36]. Furthermore, other factors which were considered as control variables in the literature such as public financing and organization's sector were not considered in this study.

3 Methods

The contextual interrelationships among the remaining drivers are identified by the application of Interpretive Structural Modeling (ISM) methodology. Finally, the drivers of eco-innovation adoption are classified into four groups of autonomous, dependent, linkage, and independent utilizing the *Matrice d'Impacts Croisés Multiplication Appliquée á un Classement* (MICMAC) method.

3.1 ISM

First introduced by Warfield [103], interpretive structural modelling (ISM) methodology introduced to deal with complex issues. It enables individuals or group of experts to develop a map of complex relationships between many factors of a complex situation [104]. The method of ISM usually is used to interpret the complex situations together with putting together courses of actions to solve the target problem [105]. This method has been used by many prestigious companies to solve complicated problems such NASA [106].

Three modelling languages constructs ISM including words, diagraphs, and discrete mathematics, which together offer a methodology to structure the complex issue. ISM is interpretive as judgement of working participants in a group to decide whether and how the factors of a complex situation are related together [104]. To develop an ISM several steps should be taken as follows [107]:

Step 1: identification of variables to be studies. In this study features that influence scholars to use a specific RMS have been identified.

Step 2: examining the contextual relationship among the variables identified in Step 1.

Step 3: indicating pair wise relationship between variables, and developing a structural self-interaction matrix (SSIM).

Step 4: developing the reachability matrix from the SSIM. Checking the transitivity of the matrix. Transitivity is the basic assumption in ISM in which states if variable X is related to variable Y, and variable Y is related to variable Z, then necessarily variable X is related to variable Z.

Step 5: through the reachability matrix developed in Step 4 partitioning of levels is done.

Step 6: based on the contextual relationships resulted from the matrix a directed graph is drawn and the transitive links are removed.

Step 7: converting the diagraph to an interpretive structural model by replacing variable nodes with statements.

Figure 1 illustrates the necessary steps to be taken for preparing ISM.

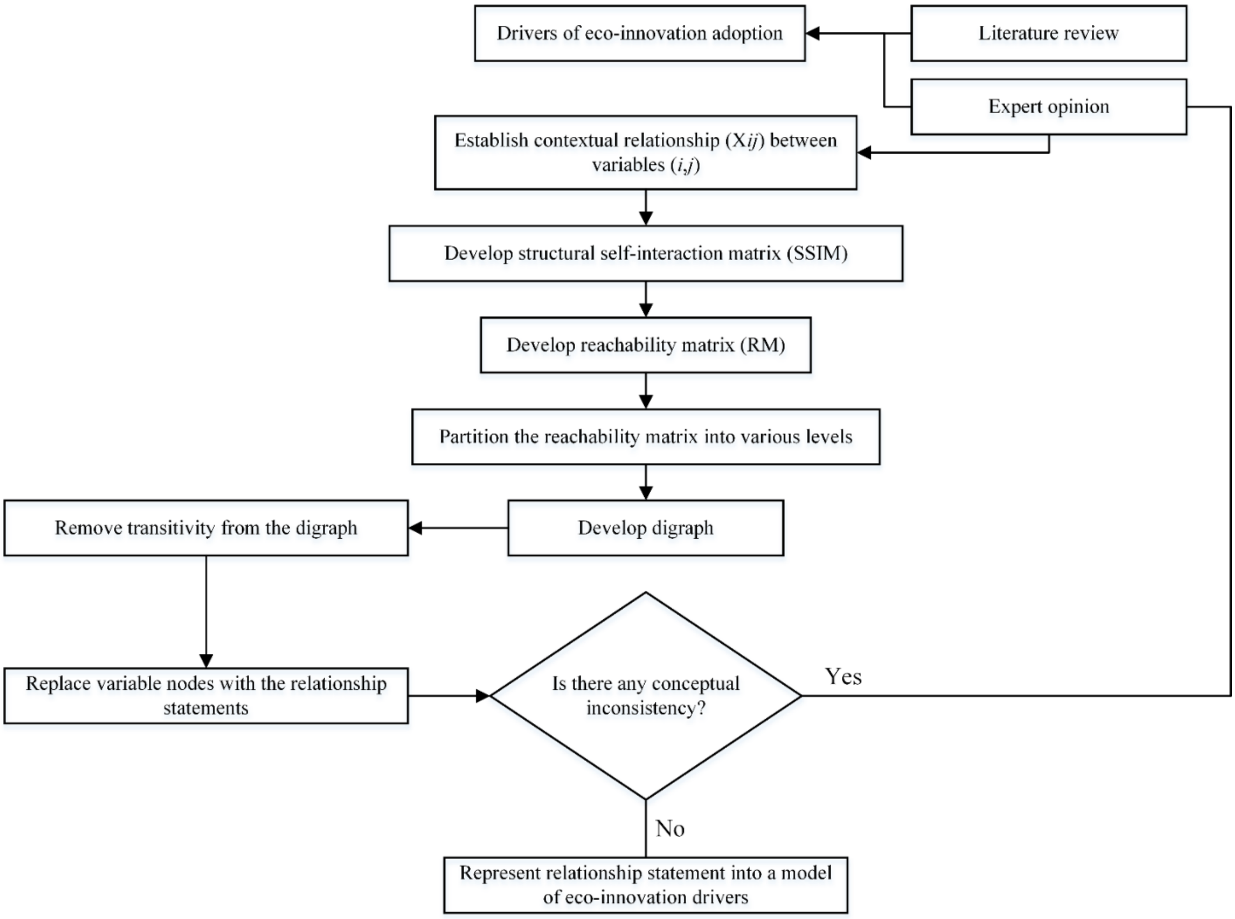

Fig. 1 Flow diagram for preparing ISM model adapted from Kannan, Pokharel [108]

Step 8: reviewing the model developed in Step 7 for any possible contextual inconsistencies and modifications.

3.2 MICMAC analysis

Matrice d'Impacts Croisés Multiplication Appliquée á un Classement (cross-impact matrix multiplication applied to classification) [109] is an approach to graphically classify factors of a complicated situation based on their driving power and dependence power. Based on driving and dependence powers, factors are classified into four clusters of 'Autonomous', 'Independent', 'Linkage', and 'Dependent'. *Independent* factors are the most important ones with high driving power and low dependency. Variables with intermediate importance are *Linkage* factors with not only high driving power but also high dependence power. *Dependent* factors are the ones that are driven by independent variables in which they have low driving power and high dependence power. The stand-alone factors are categorized under *Autonomous* variables. Both driving power and dependence power of these variables are low but they are still essential parts of the system.

Table 2 Respondents' profile

	Age			Gender		Education level	
	30-40	41-50	> 51	Male	Female	Undergraduate and below	Higher degrees
Academics	1	3	1	4	1		5
Practitioners	2	3	5	10	0	3	7
Frequency	3	6	6	14	1	3	12
Percentage	20%	40%	40%	93%	7%	20%	80%

3.3 Focus group and data collection

We found the focus groups as an appropriate data collection method for the purpose of this study. Focus groups are considered as an exploratory methodology and are specifically good for "… understanding both what people think about a topic and why they think that way …" [110]. Furthermore, various techniques such as brainstorming during focus groups sessions and well-explored literature were utilized to ensure that same results would be obtained by repetition of operations.

We have recruited 15 experts in the field including five academics and 10 practitioners who had knowledge of eco-innovation. Practitioners were manufacturing SMEs'* managers and owners located in Isfahan, Iran with the experience of eco-innovation initiatives practicing within their firms. Prior to conduct the focus group sessions, we have presented the outlines of the study's purposes and processes and further got their permission to have their voices tape-recorded for the purpose of transcription. Table 2 presents the profile of participants in the data collection procedure of this study.

4 Analysis and Results

In this section the contextual interrelationship among the identified drivers is identified and the ISM model is developed. Furthermore, the MICMAC analysis approach is utilized to classify the factors based on their driving and dependence powers.

4.1 Development of the contextual model using ISM

4.1.1 Development of structural self-interaction matrix (SSIM)

As discussed in Section 3, during the group discussion and brainstorming session conducted by academic and industry experts the contextual relationships among the identified drivers to adopt eco-innovations were identified. We have used four symbols to denote the relationships between the variables in development process of SSIM.

These four symbols are as follows:

- V – Driver 'i' leads the driver 'j';
- A – Driver 'j' leads the driver 'i';
- X – Driver 'i' and driver 'j' lead to each other;
- Drivers 'i' and 'j' are unrelated.

* These SMEs were primarily situated within the supply-chain of larger organizations located in Iran.

Table 3 Structured self-interaction matrix (SSIM) for the drivers to adopt eco-innovation

NO	Drivers to adopt eco-innovation	15	14	13	12	11	10	9	8	7	6	5	4	3	2
1	Regulatory push/pull	A	A	O	O	V	O	V	O	V	V	X	X	X	A
2	Technology push factors	A	X	O	O	V	O	V	O	V	V	X	X	V	
3	Performance	A	X	O	O	V	O	V	O	V	V	X	X		
4	Market pull factors	X	V	O	V	V	V	V	V	V	V	X			
5	Institutional isomorphisms	A	O	A	O	V	O	V	O	V	V				
6	Environmental capabilities	O	V	A	O	V	V	V	X	X					
7	Environmental leadership	O	X	O	O	V	V	V	X						
8	Environmental culture	O	O	O	O	V	V	V							
9	CSR/CER	O	A	O	O	V	X								
10	Managerial environment concerns	O	O	O	O	V									
11	Top management support	A	A	A	A										
12	Supplier involvement	O	O	O											
13	EMS	O	X												
14	Human resources	O													
15	Public pressure/awareness														

Based on the contextual relationships among the identified drivers, SSIM has been developed (see Table 3).

Driver 1 leads to driver 6 so symbol 'V' has been given to the cell (1, 6); driver 2 leads to driver 1 so symbol 'A' has been given to cell (1, 2); drivers 1 and 3 dominate to each other, hence symbol 'X' has been given to the cell (1, 3); and drivers 1 and 8 do not lead to each other so symbol 'O' has been given to the cell (1, 8). The number of pair wise comparison to construct the SSIM is ($N \times (N-1) / 2$), where N is the number of identified factors.

4.1.2 Initial reachability matrix (RM)

After developing the SSIM, the initial RM is constructed by converting the SSIM to a binary matrix. The target binary matrix is developed by substituting the symbols 'V', 'A', 'X', and 'O' by '1' or '0' based on the following rules:

- If the value of the cell (i,j) in the SSIM is the symbol 'V', then, in initial RM the values of (i,j) and (j,i) are '1' and '0', respectively;
- If the value of the cell (i,j) in the SSIM is the symbol 'A', then, in initial RM the values of (i,j) and (j,i) are '0' and '1', respectively;
- If the value of the cell (i,j) in the SSIM is the symbol 'X', then, in initial RM the values of (i,j) and (j,i) are both '1';
- If the value of the cell (i,j) in the SSIM is the symbol 'O', then, in initial RM the values of (i,j) and (j,i) are both '0';

For example, for V (1,6) in the SSIM, '1' has been given in cell (1,6) and '0' in cell (6,1) in initial RM; for A(1,2) in the SSIM, '0' has been given in cell (2,1) and '1' in cell (1,2).; for X(1,3) in the SSIM, '1' has been given in cells (1,3) and (3,1) in initial RM; and for O(1,8) in the SSIM, '0' has been given in cells (1,8) and (8,1) in the initial RM.

An initial RM has been developed based on the abovementioned rules for the drivers to adopt eco-innovation and is exhibited in Table 4.

Table 4 Initial reachability matrix for the drivers of eco-innovation adoption

NO	Drivers to adopt eco-innovation	15	14	13	12	11	10	9	**8**	**7**	**6**	**5**	**4**	**3**	**2**	**1**
1	Regulatory push/pull	0	0	0	0	1	0	1	0	1	1	1	1	1	0	1
2	Technology push factors	0	1	0	0	1	0	1	0	1	1	1	1	1	1	1
3	Performance	0	1	0	0	1	0	1	0	1	1	1	1	1	0	1
4	Market pull factors	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1
5	Institutional isomorphisms	0	0	0	0	1	0	1	0	1	1	1	1	1	1	1
6	Environmental capabilities	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0
7	Environmental leadership	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0
8	Environmental culture	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0
9	CSR/CER	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
10	Managerial environment concerns	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
11	Top management support	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
12	Supplier involvement	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0
13	EMS	0	1	1	0	1	0	0	0	0	1	1	0	0	0	0
14	Human resources	0	1	1	0	1	0	1	0	1	0	0	0	1	1	1
15	Public pressure/awareness	1	0	0	0	1	0	0	0	0	0	1	1	1	1	1

Table 5 Final reachability matrix for the drivers of eco-innovation adoption

NO	Drivers to adopt eco-innovation	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Driving Power ↓
1	Regulatory push/pull	1*	0	1*	0	1	0	1	0	1	1	1	1	1	0	1	**10**
2	Technology push factors	1*	1	0	0	1	0	1	0	1	1	1	1	1	1	1	**11**
3	Performance	1*	1	1*	0	1	0	1	0	1	1	1	1	1	0	1	**11**
۴	Market pull factors	1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	**14**
5	Institutional isomorphisms	0	0	0	0	1	0	1	1*	1	1	1	1	1	1	1	**10**
6	Environmental capabilities	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	**7**
7	Environmental leadership	0	1	0	0	1	1	1	1	1	1	0	0	0	0	0	**7**
8	Environmental culture	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	**6**
9	CSR/CER	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	**3**
10	Managerial environment concerns	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	**3**
11	Top management support	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	**1**
12	Supplier involvement	0	1*	0	1	1	0	0	0	0	0	0	0	0	0	0	**3**
13	EMS	0	1	1	0	1	0	0	0	0	1	1	0	0	0	0	**5**
14	Human resources	0	1	1	1*	1	0	1	0	1	0	0	0	1	1	1	**9**
15	Public pressure/awareness	1	1*	0	0	1	0	0	0	0	0	1	1	1	1	1	**8**
Dependence Power →		**5**	**9**	**4**	**3**	**15**	**6**	**11**	**5**	**9**	**9**	**7**	**6**	**7**	**5**	**7**	**108/108**

4.1.3 Final RM

Upon obtaining the RM, transitivity is checked for the developed matrix and further modifications are made (if necessary). Transitivity asserts that if variable X is related to variable Y, and variable Y is related to variable Z, then, necessarily variable X is related to variable Z. Accordingly, the final RM encompasses entries from the pair-wise comparison and some implied entries. After performing the described transitivity concept, the final RM is obtained in which transitivity is marked by 1*. Table 5 exhibits the obtained final reachability matrix of this study.

From this matrix, driving power and dependence power of each barrier are calculated by adding all 1s in the rows and all 1s in the columns, respectively.

4.1.4 Level partitioning

The next step in the development of ISM model of the drivers to adopt eco-innovation is to apply the level partitioning approach to remove the sequential ordering in the reachability matrix [103]. The purpose of level partitioning is to develop a digraph to depict the interrelationship among the factors from the final RM. From the final RM (see Table 5), reachability set and antecedent set [103] for each factor was obtained. Reachability set of a particular driver is a set of drivers influenced by that and the driver itself, whereas the antecedent set of a particular driver is a set of drivers influencing that driver and itself. Specifically, reachability set of driver i is the set of drivers with values of '1' and '1*' in the row i of final RM and antecedent set of driver i is the set of drivers with values of '1' and '1*' in the column i of final RM.

Reachability, antecedent, and intersection sets of all drivers have been found. Driver having the same reachability set and intersection set has been assigned as the top level driver in the ISM hierarchy [103]. Table 6 shows the first iteration of the level partitioning.

Drivers in level 1 is discarded to find further levels. Second iterations for partitioning the levels of drivers has been performed and the results are illustrated in Table 7. This iterative procedure is continued until the level of each driver is identified. Table 8 summarizes these levels.

In our study, we have identified eight levels of drivers. Top management support was identified as the top-level driver, whereas Regulatory push/pull, performance and market pull factors were found to be most important bottom level drivers.

Table 6 First iteration for partitioning the levels of drivers to adopt eco-innovation

Driver No.	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 3, 4, 5, 6, 7, 9, 11, 13, 15	1, 2, 3, 4, 5, 14, 15	1, 3, 4, 5, 15	
2	1, 2, 3, 4, 5, 6, 7, 9, 11, 14, 15	2, 4, 5, 6, 14, 15	2, 4, 5, 6, 14, 15	
3	1, 3, 4, 5, 6, 7, 9, 11, 13, 14, 15	1, 2, 3, 4, 5, 14, 15	1, 3, 4, 5, 14, 15	
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15	1, 2, 3, 4, 5, 15	1, 2, 3, 4, 5, 15	
5	1, 2, 3, 4, 5, 6, 7, 8, 9, 11	1, 2, 3, 4, 5, 13, 15	1, 2, 3, 4, 5	
6	6, 7, 8, 9, 10, 11, 14	1, 2, 3, 4, 5, 6, 7, 8, 13	6, 7, 8	
7	6, 7, 8, 9, 10, 11, 14	1, 2, 3, 4, 5, 6, 7, 8, 14	6, 7, 8	
8	6, 7, 8, 9, 10, 11	4, 5, 6, 7, 8	6, 7, 8	
9	9, 10, 11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14	9, 10	
10	9, 10, 11	4, 6, 7, 8, 9, 10	9, 10	
11	11	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15	11	**1**
12	11, 12, 14	4, 12, 14	12, 14	
13	5, 6, 11, 13, 14	1, 3, 13, 14	13, 14	
14	1, 2, 3, 7, 9, 11, 12, 13, 14	2, 3, 4, 6, 7, 12, 13, 14, 15	2, 3, 7, 12, 13, 14	
15	1, 2, 3, 4, 5, 11, 14, 15	1, 2, 3, 4, 15	1, 2, 3, 4, 15	

Table 7 Second iteration for partitioning the levels of drivers to adopt eco-innovation

Driver No.	Reachability Set	Antecedent Set	Intersection Set	Level
1	1, 3, 4, 5, 6, 7, 9, 13, 15	1, 2, 3, 4, 5, 14, 15	1, 3, 4, 5, 15	
2	1, 2, 3, 4, 5, 6, 7, 9, 14, 15	2, 4, 5, 6, 14, 15	2, 4, 5, 6, 14, 15	
3	1, 3, 4, 5, 6, 7, 9, 13, 14, 15	1, 2, 3, 4, 5, 14, 15	1, 3, 4, 5, 14, 15	
4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15	1, 2, 3, 4, 5, 15	1, 2, 3, 4, 5, 15	
5	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 2, 3, 4, 5, 13, 15	1, 2, 3, 4, 5	
6	6, 7, 8, 9, 10, 14	1, 2, 3, 4, 5, 6, 7, 8, 13	6, 7, 8	
7	6, 7, 8, 9, 10, 14	1, 2, 3, 4, 5, 6, 7, 8, 14	6, 7, 8	
8	6, 7, 8, 9, 10	4, 5, 6, 7, 8	6, 7, 8	
9	9, 10	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 14	9, 10	**2**
110	9, 10	4, 6, 7, 8, 9, 10	9, 10	**2**
11				**1**
12	12, 14	4, 12, 14	12, 14	**2**
13	5, 6, 13, 14	1, 3, 13, 14	13, 14	
14	1, 2, 3, 7, 9, 12, 13, 14	2, 3, 4, 6, 7, 12, 13, 14, 15	2, 3, 7, 12, 13, 14	
15	1, 2, 3, 4, 5, 14, 15	1, 2, 3, 4, 15	1, 2, 3, 4, 15	

Table 8 Various levels of drivers to eco-innovation adoption

Level no.	Drivers to adopt eco-innovation	Driver no.
1	Top management support	11
2	Supplier involvement	12
	Managerial environment concerns	10
	Corporate social responsibility/corporate environmental responsiveness	9
3	EMS	13
4	Environmental capabilities	6
	Environmental leadership	7
	Environmental culture	8
5	Human resources	14
6	Technology push factors	2
7	Institutional isomorphisms	5
	Public pressure/awareness	15
8	Regulatory push/pull	1
	Performance	3
	Market pull factors	4

4.1.5 ISM-based model formation for the drivers of eco-innovation adoption

Upon understanding the levels of drivers (see Table 7) and utilizing the RM (see Table 4), the structural model can be generated graphically by the aid of vertices and edges [104]. Out of 15 drivers identified for the adoption of eco- innovations by organizations (see Section 2), 'Top management support' is lying at the top level of the model. 'Regulatory push/pull', 'Performance' and 'Market pull factors' have lying at the bottom layer of the structural model. Other 11 drivers are lying between top level and bottom level drivers. Based on the ISM methodology described above, after removing the transitivity's the ISM model which called digraph is created and depicted in Figure 2.

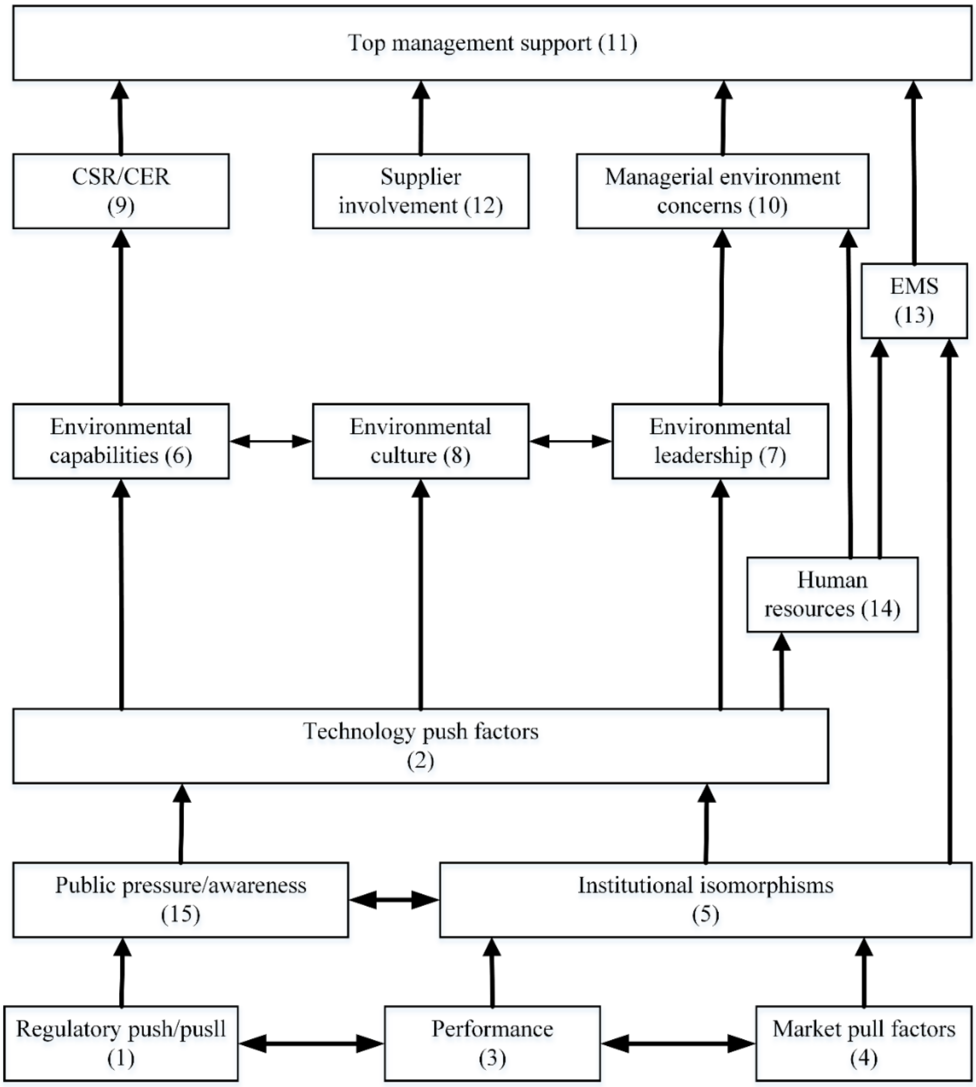

Fig. 2 ISM-based model for drivers of eco-innovation adoption

4.2 Drivers classification using MICMAC analysis

After identifying the interrelationships among the drivers and development of the ISM model, the MICMAC analysis is deployed to ascertain the degree of the relationships between those drivers. Accordingly, driving power and dependence power of drivers are analyzed using the MICMAC approach. Driving and dependence powers of each factor are obtained and presented in Table 5. High value of dependence power for a driver means that large number of drivers should be enhanced to stimulate that driver, and high value of driving power means a large number of drivers would be triggered upon improvement of that driver. Figure 3 illustrates the result of MICMAC analysis of drivers to adopt eco-innovation based on their driving and dependence powers. Identified drivers are scattered into four areas in the diagram as (1) Autonomous, (2) Dependent, (3) Independent, and (4) Linkage.

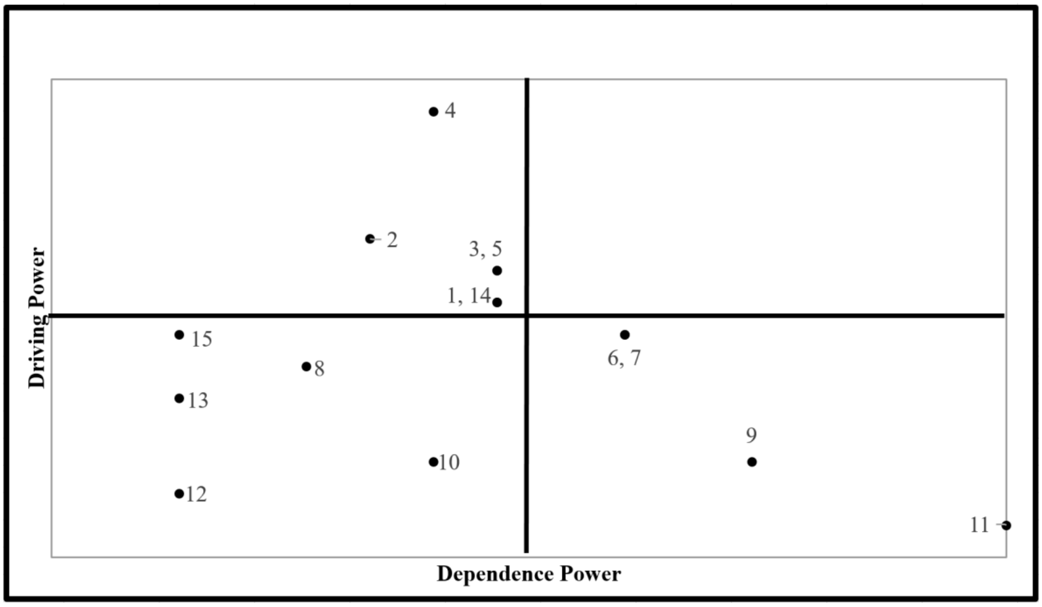

Fig. 3 MICMAC analysis for the drivers of eco-innovation adoption

5 Discussion

The ultimate goal of the organizations are constituted by satisfying the three interdependent dimension of the "triple-bottom line (TBL)" [111]. TBL suggests that besides economic efficiency activities, organizations should also engage in activities which are beneficial to the environment and the society as well. TBL is constituted of three dimensions named as economic sustainability, social sustainability, and ecological sustainability. TBL proposes that besides economic efficiency considerations, organizations should also engage in activities which are positive to the nature as well [112]. In order to gain long-term sustainability through TBL, by the aid of technology organizations are utilizing eco-innovations to tackle their environmental problems. In this study, we have conducted a literature review to identify the main drivers to adopt eco-innovations. Then, ISM method has been utilized to define the interrelationship between these drivers. Furthermore, the MICMAC analysis has been done over the results of ISM to validate the model and further classify drivers based on their driving and dependence powers.

The developed ISM model in this study depicts the hierarchy of drivers to adopt eco-innovations within corporations. This model would assist researchers, practitioners and managers to understand the interrelationships among the drivers in which

it provides a more realistic presentation of the problem (eco-innovation adoption). Accordingly, the major contribution of the developed model is the formation of the association between identified drivers to adopt eco-innovations is a single systematic structure. The ISM method utilized in this study is useful for its imposed order and direction with respect to the complicatedness of relationships among identified drivers, which would assist managers and practitioners to alleviate the adoption process in their organizations. Furthermore, these drivers are modelled according to their driving power and dependence power. Hence, factors with higher driving power are located at the bottom of the ISM model and are needed to be addressed carefully. These factors are accountable for an organization to achieve the factor 'Top management support' that is placed at the top of the hierarchy.

’Regulatory push/pull’, ‘Performance’ and ‘Market pull factors’ which are located at level 8 (bottom level) of the developed ISM model are influencing each other in a two-way relationship. These three drivers are directly influencing the two drivers located at the top of them in level 7 of the model. There is a two-way interrelationship among ‘Public pressure/awareness’ and ‘Institutional isomorphisms’ located at level 7 of the ISM model where these factors are also directly impacting the factor located at level 6 of the model. Furthermore, driver 5 (‘Institutional isomorphisms’) is directly influencing driver 13 (‘EMS’) located at level 3 of the ISM model. ‘Technology push factors’ which is placed at level 6 of the model is directly impacting the only driver placed at level 5 and also there is a direct relationship between driver 2 in level 6 and three drivers of 6,7 and 8 placed in level 4. The sole driver of eco-innovation located at level 5 (‘Human resources’) of the ISM model is impacting directly the only factor placed at level 3 and the driver 10 found at level 2 o the model. ‘Environmental capabilities’, ‘Environmental culture’ and ‘Environmental leadership’ which are placed at level 4 of the hierarchy are impacting each other in a two-way communication where drivers ‘Environmental capabilities’ and ‘Environmental leadership’ are impacting directly two drives of 9 and 10 located at layer 2 of the model, respectively. ‘EMS’ which is the sole driver placed at level three of the model is only impacting directly the driver located in top layer of the hierarchy that is driver 11. At level two of the model, three drivers of ‘Corporate social responsibility/corporate environmental responsiveness’, ‘Supplier involvement’ and ‘Managerial environmental concerns’ are impacting each other in a two-way relationship and all these three drivers are impacting directly the only driver placed at the top of the hierarchy that is ‘Top management support .‘

The key finding from the developed ISM model in this study is that, three drivers of ‘Regulatory push/pull’, ‘Performance’ and ‘Market pull factors’ are the most important drivers in motivating organizations to adopt eco-innovations. The highest driving power of these factors placed them at the bottom of the hierarchy and the two-way communication among them implies that they are impacting each other directly .

Direct arrows from the factors located at level 8 to the drivers placed at level 7 of the ISM model and consequently moving towards the driver found at level 6 of the hierarchy implies the significant impact of these drivers on the orientation of companies towards sustainable development. Hence, top management of organizations should consider that by adopting and diffusing eco-innovations they are going to enhance the performance of their corporations, save more costs, improve the image of their organization and further to increase their market share. Furthermore, the growing coverage of environmental issues by media is increasing the awareness of society, and hence, pressure to organizations to take responsibilities are rising. Consequently, firms are triggered to take corrective actions by adopting more advanced technologies to respond to public environmental concerns.

‘Top management support’ which is located at the top of the hierarchy received the highest dependence power from the analysis of the study. This factors is considered as one of the significant factors in influencing and championing the deployment of eco-innovations within organizations [113]. Eco-innovation adoption requires the support from top management and its lack hinders the adoption process. According to the ISM model, factors 2, 9, 10 and 12 from layers of 2 and 3 are directly influencing ‘Top management support’. Relationships among these factors and ‘Top management support’ which mainly concern environmental aspects and awareness of the firm, imply that organizations with the lack of support of their top managers usually ignore the environmental impact of their organizations [114]. Since, top managers often consider costs and benefits they feel that sustainability does not have potential benefits to their corporation. Accordingly, support of top managers can be enhanced by focusing more on the factors placed in different layers of the hierarchy moving towards layer 1.

Upon obtaining the interrelationships among the factor by developing the ISM model, the degree of relationship between drivers is retrieved by performing the MICMAC analysis and categorizing the factors into four groups of Dependent, Linkage, Independent and Autonomous. Based on the analysis, Autonomous drivers with weak driving and dependence powers are 'Environmental culture', 'Managerial environmental concern', 'Supplier involvement', 'EMS' and 'Public pressure/awareness'. Factors categorized as Autonomous are considered as the ones with little influence and little influence. Autonomous factors are somehow excluded from the global dynamics of the system, since they have a neutral role in stopping a major revolution in the system or in taking advantage of it. Drivers of 'Environmental capabilities', 'Environmental leadership', 'CSR/CER' and 'Top management support' were recognized as Dependent factors where their dependence power dominates their driving power. These factors are also recognized as "Resultant" factors in which they have little influence but are very dependent. In this study, these factors are greatly dependent to the enhancement and evolution of Independent factors. Independent category in which encompasses the drivers with high driving power but low dependence power includes drivers of 'Regulatory push/pull', 'Technology push factors', 'Performance', 'Market pull factors', 'Institutional isomorphisms' and 'Human resources'. Since these factors are very influential, most of the system and its factors depend on these factors. Performance of a system and its evolution crucially depends on how these factors are managed where they are usually considered as entry elements to the global system that system itself has no control over them.

According the MICMAC analysis, drivers located in the area of 'Independent' have high driving power, hence, managers and organization decision-makers should place high priority in investigating these factors and talking them in which they have great influence on other drivers of the system. Moreover, Autonomous drivers with low driving and dependence powers are disconnected from the system with few connections with other factors of the system which may these relationships be strong. None of the driving factors were identified as Linkage factors which implies that all the factors of eco-innovation adoption identified earlier are stable.

In the context of sustainable development and specifically environmental sustainability, SMEs often performed unsatisfactory and shown to be unresponsive [e.g., 115, 116-118], which this behavior of SMEs is usually related to some internal and external factors [118]. Regarding the internal factors, lack of resources such as financial, technological or human hinders environmental developments within SMEs. According to Lynch-Wood and Williamson [118] and Wilson, Williams [119], resource constraints may explain low considerations of SMEs towards environmental regulations and awareness. Stakeholders, as external factors, of SMEs are valuable sources of pressure that can motivate these firms to abide environmental regulations [120]. Due to the importance of regulations as one of the main determinants of eco-innovations within SMEs, jurisdictions are advised to formulate a proper regulatory framework [118, 121] supporting manufacturing SMEs movement towards environmental sustainability.

Top management support is highlighted in the literature as the important driver in the adoption of innovations within organizations. When an organization has the support of its top managers and champions, innovation adoption would be happened easily in that organization. Top managers are the ones who recognize the values of an innovation and support its implementation and deployment [122]. At the organization level, top management support has been found as one of the significant discriminating factors between innovation adopters and non-adopters [123]. One of the approaches to gain the support of upper echelons would be holding executive workshops [124] conducted by senior level leaders of the company discussing the opportunities of eco-innovation adoption and obstacles facing the practice of these initiatives. Another approach to gain the support of firms' top managers would be bringing the people from other companies to share their stories, ideas, experiences, and feedback around practicing of eco-innovation initiatives. In the literature, this type of motivation is highlighted in the theories of planned behavior [125] and reasoned action [126] under the construct of 'Subjective Norm'. Subjective Norm is defined as a "perceived social pressure arising from one's perception" [125]. Moreover, the significance of the influence of personal values, beliefs, and norms factors on the proenvironmental decision making process [127-129] suggest that considerable attention should be given to the personality of top managers with environmental sustainability characteristics [84]. Corporations aiming at enhancing environmental sustainability would achieve better outcomes if they screen candidates for environmental management positions on the basis of their attitudes towards eco-innovations and their moral obligation to behave proenvironmentally. As the organizational decision-makers tend to make moral judgement under intense conditions, the most important and significant trainings may include situations with less harm to others and considered as low-moral intensity situations. Hence, the researcher recommends the organizations to sensitize their managerial boards to environmental and ethical dilemmas of all degrees of intensity.

Regarding market pull factors were identified as one of the main drivers of eco-innovation adoption which placed at the lowest layer of the ISM model with highest driving power, if managers of corporations are looking for the knowledge about market pull factors they are recommended to make good relationships with customers and competitors in order obtain requirements of customers and gain knowledge of market orientation. Moreover, managers are advised to attend seminars and exhibitions which are considered as superb sources of knowledge connected to market forces. Gaining this knowledge would assist organizations to prevail various barriers of market existence.

Mangers who are more aware of the consequences of the environmental degradation and take more responsibility to remove these effects are consequently more intended to adopt eco-innovations [130, 131]. By increasing the environmental awareness individuals would ascribe more responsibility to take corrective actions towards the environment [132], in which consequently will activate their personal norm that they are obliged to behave pro-environmentally [133]. To inculcate individuals with a sense of environmental responsibility, one should try to strengthen one's awareness of adverse consequences of environmental degradation and the general environmental attitude in which both can be happen through various education methods. Perhaps besides environmental educations, organizations would benefit from field trips to ecosystems surrounding operations together with longer wilderness experiences to increase the attitude of their managers towards the natural environment.

Furthermore, due to the importance of human resources in every organization, appropriate training programs for each specific eco-innovation artefact need to be structured to meet the required technical skills and knowledge [134]. To address this, government bodies, private organizations, or eco-innovation providers may examine the skills needed to deploy these green initiatives and how they can be developed and practiced across industries. Furthermore, specific training courses and workshops may be designed for different eco-innovation initiatives.

Technological push factors and specifically R&D within each organization play a vital role in motivating firms to move towards the adoption of eco-innovations. Accordingly, rewards and incentives should be considered by the governments for the industries with a focus on research and development programs on eco-innovation. The Green Transition Scoreboard reported that, more than $240 billion was recently invested by multinational corporations like General Electric, Samsung, and Nissan in green R&D [135]. The report highlights that major investments on green R&D represents of a management bet on increasing revenue from consumers who are demanding green products and services. Research and development are the key drivers of growing green economy.

6 Conclusion

In this study an attempt has been done to identify the drivers to the adoption of eco-innovations by manufacturing SMEs and understand the interrelationship between them utilizing ISM methodology and MICMAC analysis. The interpretive structural modeling (ISM) methodology has been used to find the contextual relationships between the drivers. After conducting a literature review through two most recent published systematic literature review on eco-innovation adoption, 15 important drivers were identified and extracted. 'Regulatory push/pull', 'Performance' and 'Market pull factors' are coming at bottom of the structural model and 'Top management support' is coming at top of the structural model. The factors at the bottom of the structural model are driver factors or independent ones which means managing these drivers will have great influence on maximum number of other drivers in the system. In our ISM model, there is no Linkage drivers.

6.1 Limitations

In this study, we have developed a model of drivers to the adoption of eco-innovations based on expert's point of views and literature. There is a necessity to test the model in the real world to check the drivers and the relationship among. In the real case, the identified drivers may be incomplete or their relationships different. Although, ISM based model provides a good understanding of relationships between these drivers but it does not provide how and in what extent each driver influence other drivers to adopt eco-innovation.

6.2 Future studies

Current study elicited drivers to eco-innovation adoption from the literature, and further analyzed using ISM methodology and MICMAC analysis approach. The scope of the future study would be:

- Empirically test the model utilizing structural equation modeling (SEM) to investigate the significance and effect of each driver on other drivers based on their hypothesized relationships.
- The interrelationship among these drivers would be quantifying utilizing multi-criteria decision making models (MCDMs) such as Analytical Hierarchy Process (AHP), Analytical Network Process (ANP), Interpretive ranking process (IRP), etc.
- Increasing the sensitivity of MICMAC analysis by considering additional possible interaction among the drivers rather merely binary interaction, which is called fuzzy MICMAC analysis.

6.3 Research contributions

Successful practicing and integration of eco-innovation initiatives in all business processes of an organization will be an important issue for the coming decade. This study is among the few studies focusing on the drivers to the adoption of eco-innovations within manufacturing SMEs utilizing ISM methodology. This research made an original contribution in defining a model for the drivers of eco-innovation adoption. By enriching our understanding of the influence of drivers on the adoption of eco-innovations, the model sheds light on how governments and organizations would intend to diffuse IT and IS initiatives in organizations for the purpose of environmental sustainability.

6.4 Practical contributions

The results of this study also provide practical implications for manufacturing SMEs wishing to develop or maintain high levels of ecological responsiveness and maintain competitive edge. SMEs' managers and owners may face a lot of challenges to identify these drivers and then work on them to increase the awareness and adoption of eco-innovation in their organization. In this paper an attempt has been done to identify the most important drivers and propose some guidelines to manage them. Furthermore, the proposed structural self-interaction matrix would help organizations' managers, policy makers, and governments to understand better the drivers of eco-innovation and the relationships between them. Drivers with highest driving power are more critical in which policy makers can use the results of this study for their tactical and strategic decisions for the adoption of eco-innovation initiatives.

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