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# Drivers, barriers and incentives to implementing environmental management systems in the manufacturing industry

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A B S T R A C T

Industrial development has made major breakthroughs in the last decade in the wake of increased production, government policies and public demand. At the same time, problems related to environmental sustainability have become a major concern for producers. The unsatisfactory dimension of environmental protection has always been highlighted, because the environmental management system (EMS) is ignored and not consistently implemented in certain Tunisian companies. This increasing interest in environmental consciousness is pushing manufacturers to aspire to adopt successful environmental management strategies. Organizations are in fact increasingly responsible for monitoring and enhancing their environmental efficiency. The present work is intended to resolve these issues by establishing the essential factors and modelling their interrelationships in the Tunisian context. By reviewing literature and expert opinions, 14 critical factors have been identified which leads to responsive in the implementation of EMS- based ISO 14001. For better understanding, the MICMAC research was used to identify the critical variables according to their driving and dependence power. The present study highlights “Top management commitment and support” and “Government policies and legislation” as the most significant factors for ISO 14001 implementation. This research will facilitate organizations' readiness for implementation of ISO 14001 by providing a detailed understanding of mutual relationships among EMS factors based on ISO 14001.



## 1. Introduction

Due to market demands and environmental legislation, environmental issues have acquired high priority in an increasing number of industries. Since the launch of ISO 14000 standards in 1996, several companies across the globe have been implementing ISO 14000 and demanding that their suppliers migrate towards the same set of standards (Babakri et al., 2003). ISO 14001 is a voluntary standard which addresses environmental concerns. This norm was first published in October 1996, and then updated in 2004. ISO 14001 is a program and instrument that offers support and flexibility in managing environmental and business issues. This can be extended to all organizational styles and sizes, corresponding to the various geographical, cultural and social circumstances (Rino & Salvador, 2017). An EMS based on ISO 14001 is designed to organize the organizational and administrative activities of organization for the management of its environmental aspects and processes (Oliveira et al., 2016). The implementation of EMS is intended to help businesses substantially reduce their impact on the environment, despite being completely voluntary. An EMS is an instrument for monitoring the environmental impact of an organization's operations.

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The ISO 14001 standard includes the execution and continuous enhancement of five main elements: examination and corrective action, management review, environmental policy, planning, implementation and operation, that the organization, for certification, must satisfy (Babakri et al., 2003; Gavronski et al., 2008; Sambasivan & Fei, 2008). In reality, more and more large ISO 14001 certified companies are seeking ISO 14001 certification from their manufacturers and the various companies present in their supply chain in order to operate with them. Companies that want to stay competitive and enhance their environment cannot ignore ISO 14001 (Murmura et al., 2018; Sambasivan & Fei, 2008). Given the importance of this norm, a number of studies were carried out to understand its impact and the interactions between business operations and the environment. Further analytical studies have verified the intrinsic positive qualities in enforcing company productivity and performance environmental standards. Several authors state that companies acquired ISO 14001 certification mainly with a view to gaining commercial advantage and entering the global market (Turk, 2009; Neves et al., 2017; Zobel, 2013; Peng, 2005). Adding to this advantage, improved company image is considered as the most important benefit to ISO 14001-EMS implementation (Turk, 2009; Mazzi, 2016; Bernardo et al., 2015; Gavronski et al., 2008). Furthermore, ISO 14001 accreditation conducts to increased market benefit and financial efficiency, as well as enhanced reputation and reduced usability costs (Nguyen & Hens, 2015; Koe, 2009). Other advantages that can be achieved by implementing an effective EMS based on ISO 14001 can cover implementing costs and raise income: To boost the activities of the organization (Boiral et al., 2018; Zobel, 2018); and providing a cleaner environment through clean activities (Boiral et al., 2018; Oliveira et al., 2016).

To achieve ISO 14001 certification, a company must ensure that its management system conforms to the standards set out in the standard, as this implementation is checked by an independent certified organization. This standard's success is due to multiple factors. This assists companies in managing environmental aspects and impacts, eliminating waste and pollution, and in preventing the environment (Sambasivan & Fei, 2008; Oliveira et al., 2016, Massoud et al. 2010; Weyandt et al., 2011; Babakri et al., 2003). There are many surveys and case studies of EMS programs in developed countries (Asif and Chen, 2015; Beltrán et al., 2010 Deyassa, 2019), but there are very few studies in developing countries.

Following the above theoretical underpinnings, this work fills the void in literature by identifying the drivers due to implementing an EMS and explaining the relationship between these drivers. In fact, this research was carried in Tunisia, and we assume that the methodology and context addressed in this work could be applicable in other countries. Therefore, the study questions on which this analysis was based were:

- Which are the driving factors of ISO 14001-EMS implementation in the manufacturing context?
- What are the relationship linkages among these factors?
- Which driving factors are the most relevant?

This study is structured as follows: The first section discusses the literature survey on success factors of ISO 14001 implementation. This is followed by describing the proposed methodology used to hierarchy the success factors. Next, the results and discussions are presented. Finally, conclusions and future research directions are discussed.

## 2. Literature survey on driving factors of ISO 14001 implementation.

*Top management commitment and support (DF1):* Environmental strategy needs the involvement of top management to make a general plan or corporate policy to conduct the organization's effort to achieve the vision (Lauring & Thomsen, 2009). Top management should spread the philosophy and higher priority should be accorded to the environmental strategy and adequate resources should be allocated to execute this program. Furthermore, according to the international standard 14001 (Clause 5.1), a common presence from all levels of the company is required and this is only feasible if the top management is more dedicated.

*Environmental policies and objectives (DF2):* The basic policy contributes to the society through corporate prosperity while coexisting with the environment (Massoud et al., 2010). objectives and policy must be fixed by the organization's top management, which is also responsible for regularly updating the EMS to confirm its continued compliance and effectiveness. (Murmura et al., 2018).

*Management reviews (DF3):* Management review is a vital part of the continuous enhancement of the EMS. This concept is described in section 4.6 (ISO 14001:2004). The members of the EMS committee or core EMS team hold daily meetings to discuss and review the application of EMS to reflect the principle of continuous improvement. The top management needs to take regular actions on the EMS to safeguard that the program is acceptable, sufficient and efficient (Massoud et al. 2015).

*Training and awareness (DF4):* In the early stages of EMS design, more resources are needed because organizations must conduct a dedicated training program, extensive internal evaluations, employee training, and plan development (Darnall et al., 2007). Training is essential to improve the skills of the employees and must be clearly managed by the top management (Daily et al., 2012). All personnel whose actions may affect the environment must receive appropriate training (Jabbour, 2015). The training should cover environmental policy, relevant environmental issues and implications, EMS standards, environmental and other relevant legislation and the external certification/verification process.

*Documentation and control (DF5):* The organization, for external and internal communication, will have a clearly defined source of documentation and will preserve it. Documents should be descriptive, datable (with revision dates) and readily recognizable (Pheng & Tan, 2005; Gopalakrishnan et al., 2015). It should also develop and maintain protocols for the proper review of all EMS documents (Khan, 2006; Boiral et al., 2017).

*Communication (DF6):* The most important outcome of ISO 14001 certification was increased communication and interaction between staff and management. Good communication is important for an organization to inspire its workers, tell them what steps they will take to protect the environment (Heras & Arana, 2010; Massoud et al., 2010; Nguyen & Hens, 2015).

*Emergency response and preparedness (DF7):* The organization should establish and manage policies for the prevention and mitigation of environmental impacts which may occur from incidents and emergencies (Christini et al., 2004; Widaningrum, 2016). Also, it should develop, build and maintain protocols for the prevention and mitigation of environmental effects that may occur from incidents and emergencies (Tammepuu, 2016; Halila; 2007).

*Market pressure (DF8):* Companies seek certification because of several pressures, such as customer requests, other stakeholder pressures or, more generally, to enhance their reputation. The organization's improved brand image helps increase the sales volume and attract high-quality staff (Fryxell et al., 2004; Deyassa, 2019). ISO 14001-EMS is considered by certain authors as a marketing tool (Anne et al., 2014; Turk, 2009).

*Government policies and legislation (DF9):* Several developed and developing countries have adopted stringent environmental legislation to avoid environmental harm (Salim et al., 2019, Omri and Ben Mabrouk, 2020). EMS based on ISO 14001 allows organizations to comply with the guidelines set out in the legislation (Waxin et al., 2019; Thornton, 2000, Liu et al., 2020).

*Customer satisfaction (DF10):* Organizations adopting ISO 14001-EMS are focused on providing the consumer with superior value and enhancing process performance (Gavronski et al., 2008). Most multinational corporations embrace EMS in response to consumer demand (Kaynak, 2003). Customer satisfaction is also considered as a measure of the success of TQM efforts (Bernardo et al., 2015).

*Employee relations (DF11):* Organizations that implement EMS based on ISO 14001 may have a wider pool of potential workers to choose from their rivals, offering them a competitive advantage. Workplace participation is essential to the successful functioning of the EMS. High quality employees and their productivity will definitely raise employee engagements within the company, making it much easier to adopt the EMS (Chin et al., 1999; Oliveira et al., 2016).

*Production process enhancement (DF12):* The surveillance and control tools may be used to improve manufacturing processes in order to make them more environmentally friendly. Operational efficiency is typically a measure of the willingness of a company making good use of its capabilities to achieve its goals (Chin et al., 1999; Nguyen & Hens, 2015).

*Monitoring and measuring equipment (DF13):* Until it's measured, quality cannot be improved. Statistical methods are an integral part of ISO 14001. The ISO 14001 standard describes metrological specifications for EMSs in its Section 4.5.1 Monitoring and Measurement, aiming to provide accountability for the outcomes of all the organizational measurement and verification procedures (Beltrán et al., 2010; Padma et al., 2008).

*Environmental specialist assistance (DF14):* Environmental expert assistance in identifying and evaluating the technical issues affecting the activities of an agency that may have significant environmental effects (Boiral et al., 2017). Most organizations have no experience in designing and implementing an EMS. Such organizations are seeking environmental skills to assist them in designing and implementing EMS according to ISO 14001 (Chavan, 2005; Lin, 1995; Tan, 2005).

## 3. Research methodology

This study analyses the drivers to implement ISO 14001-EMS using ISM to rank the importance drivers according to their importance. ISM was initially proposed enabling groups or individuals to create a map of the dynamic relationships to create a diagram of dynamic user knowledge-based interactions and functional understanding to build component hierarchy (Warfield, 1974). Though the interview findings revealed variables affecting ISO 14001 implementation. Decisions concerning interrelationships among the variables in the ISM technique are based on decisions of the expert opinions.

ISM was widely extended to a variety of areas, such as worker safety (Shakerian, 2019, Ibrahim & Ben Mabrouk, 2021), lean Six Sigma (Kaswan & Rathi, 2019, Ben Mabrouk et al., 2021), sustainable manufacturing (Thirupathi & Vinodh, 2016; Malek and Desai, 2019, Ben Mabrouk, 2021), supply chain management (Majumdar and Sinha, 2019; Ben Mabrouk, 2020a), lean remanufacturing practices (Vasanthakumar et al., 2016) and buyer-supplier relationships (Thakkar et al., 2007; Ben Mabrouk, 2020b).

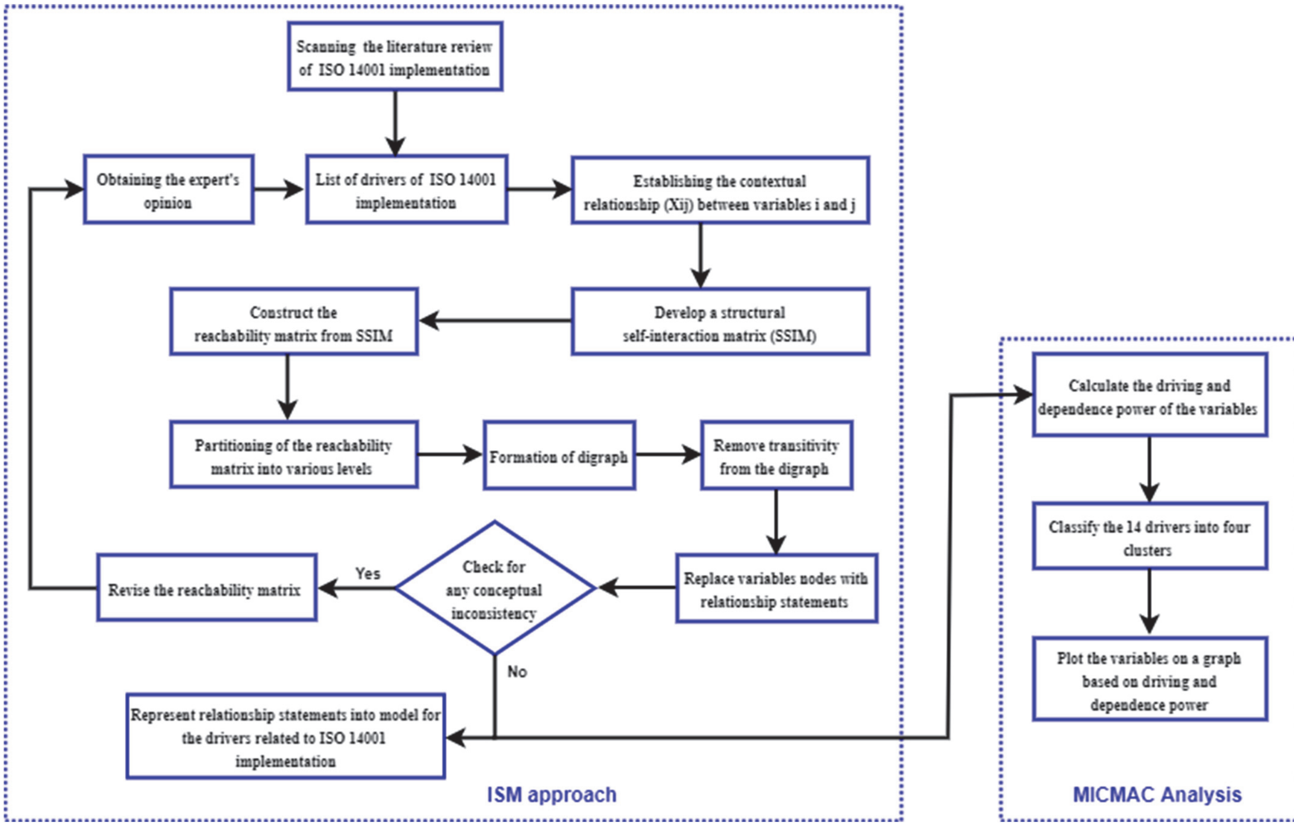


**Fig. 1.** ISM-MICMAC Flow chart for ISO 14001 implementation

Compared to other methods such as Structural Equation Modeling (SEM) and Delphi, the ISM needs fewer experts (Yadav & Barve, 2015; Barve et al., 2007). The ISM turns vague and poorly formulated systems models into recognizable and well-defined models. Firstly, to decide on the variables defining the ISO 14001 program in the suggested ISM method by conducting a literature review and discussions with environmental experts. After the identification of critical factors, a contextual relationship is examined in order to develop a structural self-interaction matrix (SSIM). Then, a reachability matrix is established based on SSIM. The steps for the suggested ISM method are presented in Fig. 1. Subsequently, by using the MICMAC approach, the critical success factors of ISO 14001 implementation are divided into four groups with respect to their driving and dependence power (Fig. 1).

### *3.1 Identification of factors*

The main critical factors of ISO 14001 implementation were established based on analysis of literature and discussion with experts. This study considered 14 relevant factors of ISO 14001 implementation based on discussion with experts. For this research a group of 44 experts was taken into account. Such experts include business specialists, environmental executives and policy-makers with specific environmental management expertise. Thirty-two experts replied with (72.72%) response rate. Twelve (37.5%) of them had more than 15 years of experience and fourteen (43.75%) had between 10 and 15 years of experience. The majority of respondents have an environmental position such as: Senior environmental engineer, environmental manager, environmental project manager and corporate environmental manager.

**Table 1**
Driving factors influencing ISO 14001-EMS implementation

| Driving factors | References |
|---|---|
| **DF1** | Lauring and Thomsen, 2009; Latan et al., 2018 |
| **DF2** | Murmura et al., 2018; Massoud et al., 2010 |
| **DF3** | Massoud et al., 2015 |
| **DF4** | Darnall et al., 2007; Daily et al., 2012; Jabbour, 2015 |
| **DF5** | Pheng, L. S., & Tan, 2005; Gopalakrishnan et al., 2015; Khan, 2006; Boiral et al., 2017 |
| **DF6** | Christini et al., 2004; Widaningrum, 2016; Tammepuu, 2016; Halila; 2007 |
| **DF7** | Heras and Arana, 2010; Massoud et al., 2010; Nguyen and Hens, 2015 |
| **DF8** | Fryxell et al., 2004; Deyassa, 2019; Turk, 2009 |
| **DF9** | Salim et al., 2019; Waxin et al., 2019; Thornton, 2000, Liu et al., 2020 |
| **DF10** | Kaynak, 2003; Gavronski et al., 2008; Bernardo et al., 2015 |
| **DF11** | Chin et al., 1999; Oliveira et al., 2016 |
| **DF12** | Chin et al., 1999; Nguyen and Hens, 2015 |
| **DF13** | Beltrán et al., 2010; Padma et al., 2008 |
| **DF14** | Chavan, 2005; Lin, 1995; Boiral et al., 2017 |

### *3.2 Development of correlation structure*

The interrelationship among the fourteen critical factors is formulated by the SSIM (Table 2), that represents the relationship between components of the system in pairs. The relationship between factors i and j is represented by the following notation (V, A, X and O) were, V: used if *i* affects *j*; A: if *j* affects *i*; X: if *i* and *j* are related and O: if *i* and *j* are not related.

**Table 2**
SSIM of ISO 14001 implementation

| i/j | DF1 | DF2 | DF3 | DF4 | DF5 | DF6 | DF7 | DF8 | DF9 | DF10 | DF11 | DF12 | DF13 | DF14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF1** | *X* | *V* | *V* | *V* | *V* | *O* | *V* | *V* | *O* | *O* | *V* | *O* | *V* | *V* |
| **DF2** | | *X* | *V* | *V* | *V* | *V* | *V* | *O* | *A* | *V* | *V* | *V* | *O* | *X* |
| **DF3** | | | *X* | *V* | *V* | *V* | *V* | *V* | *A* | *O* | *V* | *V* | *O* | *A* |
| **DF4** | | | | *X* | *V* | *V* | *X* | *O* | *O* | *O* | *V* | *O* | *X* | *A* |
| **DF5** | | | | | *X* | *V* | *A* | *O* | *A* | *O* | *O* | *V* | *V* | *A* |
| **DF6** | | | | | | *X* | *A* | *V* | *A* | *O* | *O* | *V* | *A* | *A* |
| **DF7** | | | | | | | *X* | *V* | *O* | *V* | *V* | *V* | *V* | *A* |
| **DF8** | | | | | | | | *X* | *O* | *X* | *A* | *A* | *A* | *O* |
| **DF9** | | | | | | | | | *X* | *O* | *O* | *O* | *V* | *V* |
| **DF10** | | | | | | | | | | *X* | *O* | *A* | *A* | *O* |
| **DF11** | | | | | | | | | | | *X* | *X* | *A* | *A* |
| **DF12** | | | | | | | | | | | | *X* | *A* | *O* |
| **DF13** | | | | | | | | | | | | | *X* | *A* |
| **DF14** | | | | | | | | | | | | | | *X* |

### *3.2 Reachability matrix*

The initial reachability matrix (IRM) is established from SSIM by using the following rules (Table 3): If the $(i, j)$ value is $V$ in the SSIM, the corresponding $(i, j)$ value in the IRM is denoted as 1 and $(j, i)$ value is denoted as 0. If the $(i, j)$ value is A in the SSIM, the corresponding $(i, j)$ value in the IRM is represented by 0 and $(j, i)$ entry by 1. If the $(i, j)$ value is *X* in the SSIM, the corresponding $(i, j)$ value in the IRM is represented by 1 and $(j, i)$ value by 1. If the $(i, j)$ value is O in the SSIM, then substitute that by 0 and $(j, i)$ value to be made 0.

**Table 3**
IRM of EMS based ISO 14001 implementation

| i/j | DF1 | DF2 | DF3 | DF4 | DF5 | DF6 | DF7 | DF8 | DF9 | DF10 | DF11 | DF12 | DF13 | DF14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF1** | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 1 |
| **DF2** | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 0 | 1 |
| **DF3** | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| **DF4** | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| **DF5** | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| **DF6** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 |
| **DF7** | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| **DF8** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| **DF9** | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| **DF10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| **DF11** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| **DF12** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| **DF13** | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| **DF14** | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |

The final reachability matrix (FRM) is obtained from the IRM by adding transitivity rules (Table 4), which is a fundamental hypothesis given in ISM, affirming that if variable $x1$ is connected to $x2$ and variable $x2$ is connected to variable $x3$, then variable $x1$ is necessarily connected to variable $x3$ (Kumar et al., 2015). In addition, if variables $x1$ and $x2$ are related and variables $x2$ and $x4$ are related, then variable $x1$ is necessarily connected to variable $x4$ (Fig.2).

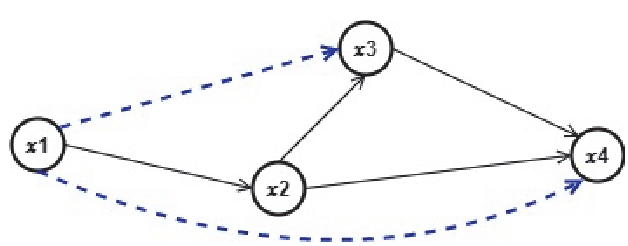


**Fig. 2.** Transitivity rules

**Table 4**
FRM of ISO 14001 factors

| i/j | DF1 | DF2 | DF3 | DF4 | DF5 | DF6 | DF7 | DF8 | DF9 | DF10 | DF11 | DF12 | DF13 | DF14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **DF1** | 1 | 1 | 1 | 1 | 1 | 1* | 1 | 1 | 0 | 1* | 1 | 1* | 1 | 1 |
| **DF2** | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1* | 0 | 1 | 1 | 1 | 1* | 1 |
| **DF3** | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1* | 1 | 1 | 1* | 0 |
| **DF4** | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1* | 0 | 1* | 1 | 1* | 1 | 0 |
| **DF5** | 0 | 0 | 0 | 1* | 1 | 1 | 0 | 1* | 0 | 1* | 1* | 1 | 1 | 0 |
| **DF6** | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 1* | 1* | 1 | 0 | 0 |
| **DF7** | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| **DF8** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| **DF9** | 0 | 1 | 1 | 1* | 1 | 1 | 1* | 1* | 1 | 1* | 1* | 1* | 1 | 1 |
| **DF10** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| **DF11** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1* | 1 | 1 | 0 | 0 |
| **DF12** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 |
| **DF13** | 0 | 0 | 0 | 1 | 1* | 1 | 1* | 1 | 0 | 1 | 1 | 1 | 1 | 0 |
| **DF14** | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1* | 0 | 1* | 1 | 1* | 1 | 1 |

Following application of the above principles and consideration of the role of transitivity in expert opinions, The FRM was built, as presented in Table 4. Entry 1 means that the factor *i* influences the factor *j*. In contrast, entry 0 means that the factor *i* does not influence the factor *j*. Entry 1* represents transitivity property checked.

### *3.3 Level partition*

Reachability set (RS), antecedent set (AS) and intersection set (IS) for factors are developed from the FRM. RS of each factor itself together with others whom it assists to attain, whereas AS includes of the factors themselves and the other factors, which can help to make it happen. Subsequently, IS is obtained for all the critical factors. The factors which have similar RS and IS in earlier iteration are located at the highest level of the ISM hierarchy. The level partition process for the two first iterations is presented in Tables 5 and 6. From Table 5, could be noted that factors (F8 and F10) have a common set of antecedents and intersections, thus defining the first stage for the structure of ISM. The top-level factor is removed and this process is repeated iteratively until variables at all levels are determined, as shown in Table 7.

**Table 5**
Level partition for iteration 1

| Factors | RS | AS | IS | level |
|---|---|---|---|---|
| **DF1** | 1 2 3 4 5 6 7 8 10 11 12 13 14 | 1 | 1 | |
| **DF2** | 2 3 4 5 6 7 8 10 11 12 13 14 | 1 2 9 14 | 2 14 | |
| **DF3** | 3 4 5 6 7 8 10 11 12 13 | 1 2 3 9 14 | 3 | |
| **DF4** | 4 5 6 7 8 10 11 12 13 | 1 2 3 4 5 7 9 13 14 | 4 5 7 13 | |
| **DF5** | 4 5 6 8 10 11 12 13 | 1 2 3 4 5 7 9 13 14 | 4 5 13 | |
| **DF6** | 6 8 10 11 12 | 1 2 3 4 5 6 7 9 13 14 | 6 | |
| **DF7** | 4 5 6 7 8 10 11 12 13 | 1 2 3 4 7 9 13 14 | 4 7 13 | |
| **DF8** | 8 10 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 | 8 10 | **L1** |
| **DF9** | 2 3 4 5 6 7 8 9 10 11 12 13 14 | 9 | 9 | |
| **DF10** | 8 10 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 | 8 10 | **L1** |
| **DF11** | 8 10 11 12 | 1 2 3 4 5 6 7 9 11 12 13 14 | 11 12 | |
| **DF12** | 8 10 11 12 | 1 2 3 4 5 6 7 9 11 12 13 14 | 11 12 | |
| **DF13** | 4 5 6 7 8 10 11 12 13 | 1 2 3 4 5 7 9 13 14 | 4 5 7 13 | |
| **DF14** | 2 3 4 5 6 7 8 10 11 12 13 14 | 1 2 9 14 | 2 14 | |

**Table 6**
Level partition for iteration 2

| Factors | RS | AS | IS | level |
|---|---|---|---|---|
| **DF1** | 1 2 3 4 5 6 7 11 12 13 14 | 1 | 1 | |
| **DF2** | 2 3 4 5 6 7 11 12 13 14 | 1 2 9 14 | 2 14 | |
| **DF3** | 3 4 5 6 7 11 12 13 | 1 2 3 9 14 | 3 | |
| **DF4** | 4 5 6 7 11 12 13 | 1 2 3 4 5 7 9 13 14 | 4 5 7 13 | |
| **DF5** | 4 5 6 11 12 13 | 1 2 3 4 5 7 9 13 14 | 4 5 13 | |
| **DF6** | 6 11 12 | 1 2 3 4 5 6 7 9 13 14 | 6 | |
| **DF7** | 4 5 6 7 11 12 13 | 1 2 3 4 7 9 13 14 | 4 7 13 | |
| **DF8** | 2 3 4 5 6 7 9 11 12 13 14 | 9 | 9 | |
| **DF9** | 11 12 | 1 2 3 4 5 6 7 9 11 12 13 14 | 11 12 | **L2** |
| **DF10** | 11 12 | 1 2 3 4 5 6 7 9 11 12 13 14 | 11 12 | **L2** |
| **DF11** | 4 5 6 7 11 12 13 | 1 2 3 4 5 7 9 13 14 | 4 5 7 13 | |
| **DF12** | 2 3 4 5 6 7 11 12 13 14 | 1 2 9 14 | 2 14 | |

**Table 7**
Level partition after final iteration

| Factors | RS | AS | IS | level |
|---|---|---|---|---|
| **DF1** | 1 2 3 4 5 7 13 14 | 1 | 1 | **L8** |
| **DF2** | 2 3 4 5 7 13 14 | 1 2 9 14 | 2 14 | **L7** |
| **DF3** | 3 4 5 7 13 | 1 2 3 9 14 | 3 | **L6** |
| **DF4** | 4 5 7 13 | 1 2 3 4 5 7 9 13 14 | 4 5 7 13 | **L4** |
| **DF5** | 4 5 13 | 1 2 3 4 5 7 9 13 14 | 4 5 13 | **L4** |
| **DF6** | 6 | 1 2 3 4 5 6 7 9 13 14 | 6 | **L3** |
| **DF7** | 4 5 7 13 | 1 2 3 4 7 9 13 14 | 4 7 13 | **L5** |
| **DF8** | 8 10 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 | 8 10 | **L1** |
| **DF9** | 2 3 4 5 7 9 13 14 | 9 | 9 | **L8** |
| **DF10** | 8 10 | 1 2 3 4 5 6 7 8 9 10 11 12 13 14 | 8 10 | **L1** |
| **DF11** | 11 12 | 1 2 3 4 5 6 7 9 11 12 13 14 | 11 12 | **L2** |
| **DF12** | 11 12 | 1 2 3 4 5 6 7 9 11 12 13 14 | 11 12 | **L2** |
| **DF13** | 4 5 7 13 | 1 2 3 4 5 7 9 13 14 | 4 5 7 13 | **L4** |
| **DF14** | 2 3 4 5 7 13 14 | 1 2 9 14 | 2 14 | **L7** |

## 4. Formation of ISM model

The final ISM hierarchy of factors affecting ISO 14001 implementation is obtained from both the FRM and the level partition presented in the previous section. If the factors i and j are related, this is presented by an arrow pointing from *i* to *j*. After the transitivity is eliminated, the diagram is eventually translated to the ISM form, as seen in Fig. 3. The various levels are defined using the ISM method's level partitioning mechanism, which indicates a variable's driving and dependency force, and how they are related at the same level and with the next level variables above.

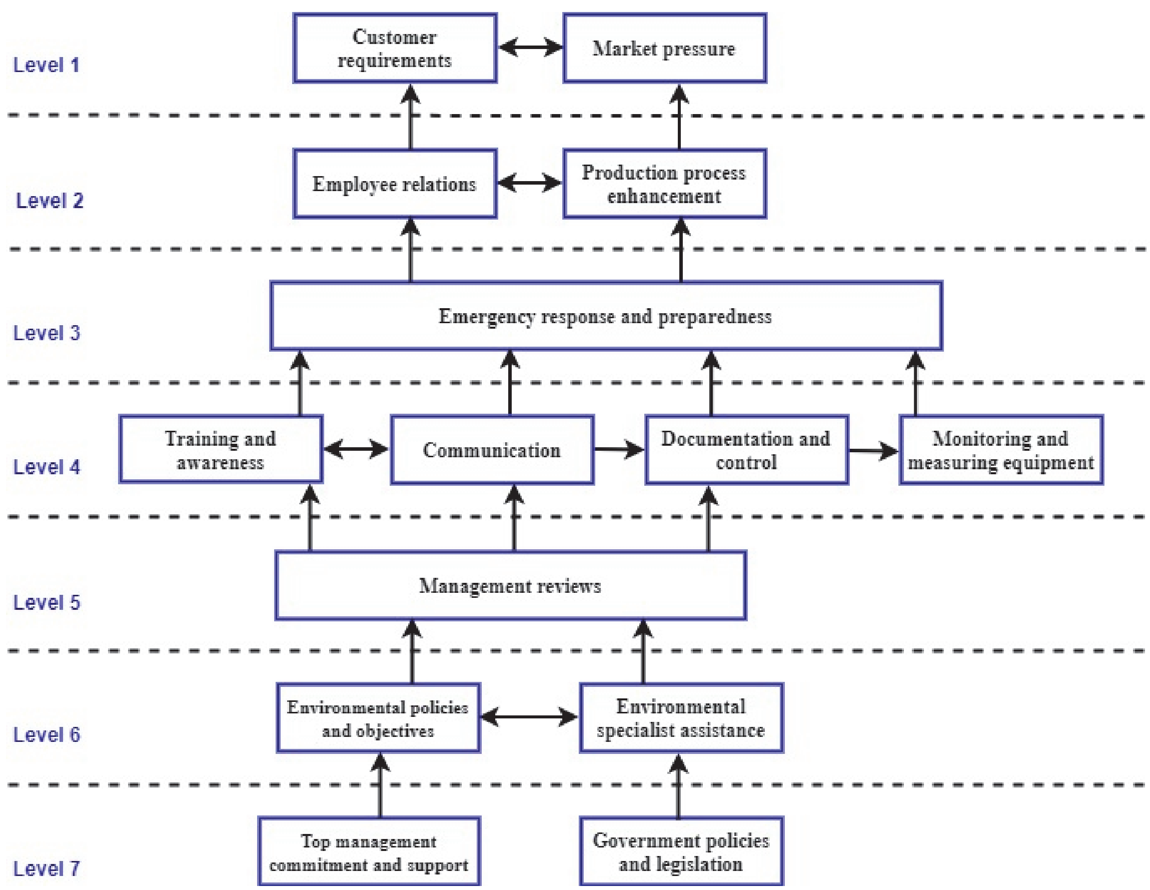


**Fig. 3.** ISM model of drivers to ISO 14001 implementation

## 5. Classification of factors impacting the ISO 14001 implementation

MICMAC is an incredibly basic but effective study to evaluate the driving power (DRP) and dependence power (DNP) of the various elements used in ISM. These fourteen factors are classified by transforming the reachability matrix into a MICMAC diagram. DRP and DNP of one element is obtained when you add all entries in the corresponding row and the corresponding column, respectively of FRM, as shown in Table 8. For example, Management reviews (DF3) has DRP of teen and DNP of five. This indicates that DF3 impacts or drives teen factors and it is influenced or driven by five factors.

The fourteen factors are divided into four groups. There are five independent factors with high DRP and low DNP: F6 (Emergency response and preparedness), DF8 (Market pressure), DF10 (Customer requirements), DF11 (Employee relations) and DF12 (Production process enhancement). There are five dependent factors with low DRP and high DNP: DF1 (Top management commitment and support), F2 (Environmental policies and objectives), DF3 (Management reviews), DF9 (Government policies and legislation) and DF14 (Environmental specialist assistance). There are four linkage elements with high DRP and high DNP: DF4 (Training and awareness), DF5 (Documentation and control), DF7 (Communication) and DF13 (Monitoring and measuring equipment). Such variables affect one another, as well as feedback on themselves. No factor is identified to be an autonomous element, which indicates that all fourteen factors can contribute in implementing ISO 14001 in a more or less manner. The MICMAC empirical findings complement the framework of the ISM hierarchy by defining the DRP and DNP of each factor.

**Table 8**
DRP and DNP of ISO 14001 factors

| *Factors* | DF1 | DF2 | DF3 | DF4 | DF5 | DF6 | DF7 | DF8 | DF9 | DF10 | DF11 | DF12 | DF13 | DF14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***DRP*** | 13 | 12 | 10 | 9 | 8 | 5 | 9 | 2 | 13 | 2 | 4 | 4 | 9 | 12 |
| ***DNP*** | 1 | 4 | 5 | 9 | 9 | 10 | 8 | 14 | 1 | 14 | 12 | 12 | 9 | 4 |

*DRP: Driving Power, DNP: Dependence Power*

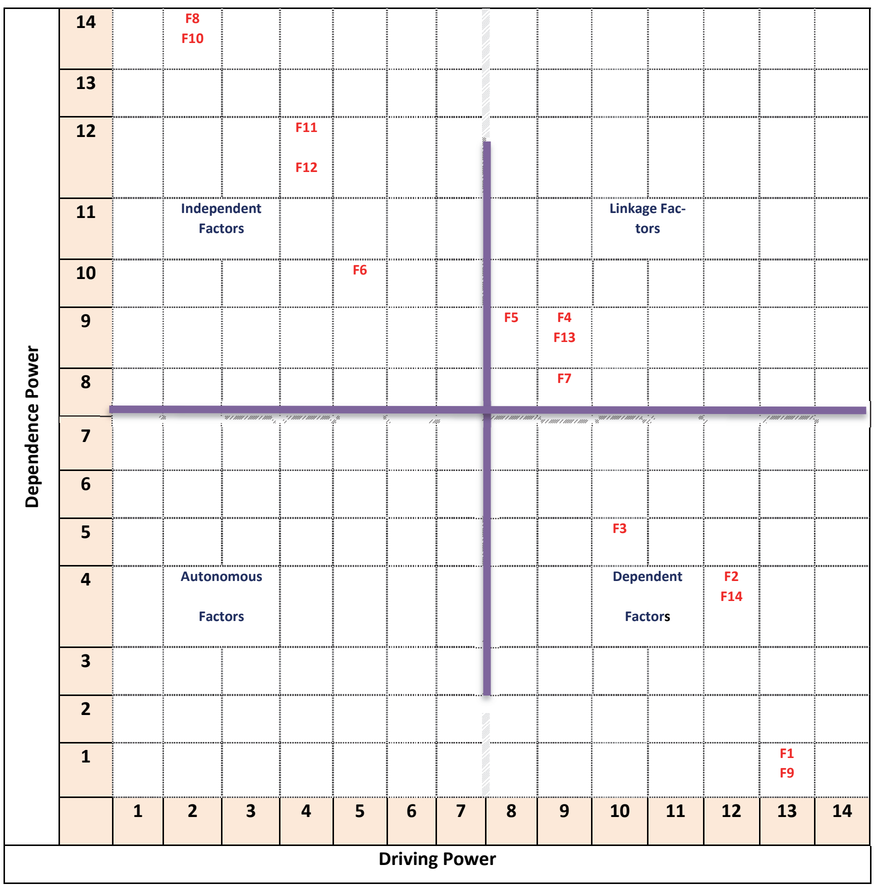


**Fig. 4.** Clusters of factors influencing ISO 14001 implementation

## 6. Results and discussions

The findings of the study were outlined in Fig. 3 and Fig. 4 in the section above. Fig. 3 displays the digraph that indicates the relationships between different drivers of ISO 14001 application. Drivers are organized in a hierarchical system, in seven levels. Variables at the lower hierarchy level influence the upper level variables. Fig. 4 displays the variables distribution from the DRP and DNP viewpoints. From the two figures as can be seen that “driving or dependent factors” (Fig.4) are in the three bottom levels in the ISM model (Fig. 3), including DF9 (Government policies and legislation), DF14 (Environmental specialist assistance), DF1 (Top management commitment and support), CSF2 (Environmental policies and objectives) and CSF3 (Management reviews). This indicates that key steps and initiatives should be taken to address these variables.

In particular, considering that they are at the highest stage and have the greatest driving force, the variables DF1 and DF9 should be given top priority to consider. Top management commitment and support (DF1), which is a management attitude related attribute, is the most elementary factor which drives the ISO 14001 implementation. In the Implementation of ISO 14001, where constructive management guidance can be given to accelerate the necessary transition, is essential. It also plays a significant role in directing the preparation and deployment of ISO 14000 programs. To do that, it seems that it is necessary to have effective environmental policies and objectives (DF2), since it is seen to be at the second lower level.

On the other hand, the Government is getting more proactive and offering more tools to enact laws on the environment. Government policies and legislation (DF9) is deemed the most important factor for the success of the ISO 14001 implementation. Subsequently, consultants should create and enforce effective intervention measures to enhance the environmental efficiency of the company in a realistic way which leads to compliance with environmental legislation. It is appreciated that the environmental specialist assistance (DF14) impacts other factors, owing to their lack of understanding management technology of pollution prevention, manufacturers are calling for the assistance of specialists in the environmental area and considering this factor as an essential element for ISO 14001 implementation.

In the third lower level, Management reviews (DF3) must be focused on the findings of the EMS audit and will discuss all potential demands for improvements required in the environmental management system's strategies, goals and other components, changing conditions and dedication to quality improvement.

As can be seen from the two figures (3 and 4) that “linkage factors” are positioned at middle level of the ISM hierarchy (Fig. 3), including DF4 (Training and awareness), CSF5 (Documentation and control), DF7 (Communication) and CSF13 (Monitoring and measuring equipment). This ensures that organizations looking to adopt EMS based on ISO 14001 will be able to formulate strategies to address these three drivers of organizational change (DF4, DF5 and DF7). The company will develop and manage internal as well as external communication procedures. Also, the company will develop and retain protocols for careful monitoring of all EMS documentation. Furthermore, adopting the ISO 14001-based program involves significant organizational improvements not only in obtaining employee interest and participation, but also to get them to learn ISO 14000 specifications, reporting and monitoring, and continuous enhancement of the environmental performance. Another linkage element is monitoring and measuring equipment (DF13), which is a technical factor. While adopting ISO 14000 program, organizations need accurate testing and measurement equipment to track and quantify all operations on a daily basis and may have major environmental damage.

As can be seen from the two figures that, the five dependent factors (DF6, DF8, DF10, DF11 and DF12) as shown in Fig. 4, situating at the three top levels (L1, L2 and L3) of the ISM hierarchy structure (Fig. 3), are driven by driving variables and linkage variables. These depending variables are characterized with low DRP and high DNP. When the driving variables and linkage variables can be handled properly, the efficiency of these dependent variables can be increased as needed. For instance, for the emergency response and preparedness (DF6), the company will develop and manage protocols for recognizing possible incidents and emergency situations and responding to them. The current manufacturing facilities and activities of largest companies, of particular SMEs, is unable to fulfill ISO 14001 standards for regulatory enforcement and effective efficiency in the field. In addition, the manufacturing process (DF12) also needs to be enhanced so that they are more environmentally sustainable.

The critical success factors DF8 (Market pressure) and DF10 (Customer requirements) are placed in the highest hierarchical level. These factors represent the wanted objectives of the ISO 14001 implementation. In fact, compliance with the ISO 14001-based EMS standard will help the business remain competitive on the market and be able to satisfy consumer demands. For several businesses, both their rivals are pursuing certification and their clients are continuing to expect compliance with ISO14001 standards Adopting ISO 14001 will lead to positive views of the public and give organizations a comparative edge in competing on the international marketplace.

## 7. Conclusions and prospects of future research

Sustainability and ecological problems have been addressed in recent years and several companies are introducing ISO 14001-based EMS to boost their businesses. In addition, this certification is becoming an important prerequisite for good environmental standards in companies all over the world. In line with developments in world business ISO 14001 has been evolving over time. The new edition of the ISO 14001:2015 specification emphasizes sustainable development and maintaining an environmental, social and economic balance. There are also related benefits to ISO 14001 implementation such as protection of the environment, profitability, effectiveness, enhanced image, improved customer satisfaction and upgraded employee outcomes (Gavronski et al., 2008). However, the ISO 14001 implementation in Tunisian context still remains in its infancy. Fourteen drivers pertaining to the implementation of ISO 14001 have found it appropriate to model and analyze this problem by using the ISM-MICMAC approach. Past research typically established only essential factors affecting the introduction of ISO 14001 (Babakri et al., 2003; Massoud et al., 2010; Oliveira et al., 2026; Sambasivan and Fei, 2008; Chin et al., 1999). This research, by comparison, is the specific attempt to understand the interactive relationship between those variables. The

ISM approach serves as an effective method for establishing the relationship between different ISO 14001 implementation factors. The 14 identified drivers are arranged in a hierarchy using ISM analysis, and divided into seven distinct groups. The ISM model is generated after the transitivity relations are removed and the node numbers are replaced with statements. Then, by applying the MICMAC analysis we establish a classification of these drivers according to their DRP and DNP. Five drivers are found as independent factors whereas four as linkage factors. Five drivers are found as dependent and no autonomous drivers were identified (Fig. 4). These results provide useful insights into the importance of resource management to overcome these factors. In addition, these findings are important for practitioners and managers by investigating the relationship between different factors which provide a systematic way of initiating and implementing the EMS program.

As a result of the analysis, it can be recommended that environmental managers should pay attention to these variables and use their tools and resources to resolve them like top management commitment and support, government policies and legislation, environmental policies and objectives, environmental specialist assistance and management reviews. Therefore, when establishing such a strategy, the top management must actively engage to ensure that it is properly conveyed to all levels of functions within the organization. Additionally, they will provide middle managers with strategic guidance to engage in the development of environmental policy and effective program implementation plans. At the same time, the government is sensitive to provide more tools to implement environmental law. Government should be done to encourage organizations to implement what, if any, changes in public policy should be made in light of the fact that organizations are already implementing EMS. On the other hand, environment policy is the process by which top management communicates formally its commitment to enhancing its efficiency in the environment. Then, environmental specialists will establish and enforce the required response measures to enhance the environmental performance of the company in a realistic manner ensuring compliance of environmental laws.

The proposed structural model was used effectively to make the structure noticeable by evaluating the ISO 14001 clauses and considering fourteen factors prevalent in the application of the EMS but it may not be the complete list of factors. There could be some other considerations too. Notwithstanding, ISM provides valuable insight and guidance of the correlation between main factors of ISO 14001 implementation, but this cannot quantify the impact of each factor. With one factor the effect of one factor over another may be very high and for another factor may be a little high. In all these cases, they will present the relationship as 1. A fuzzy theory will be combined with the MICMAC analysis to address this limitation.

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