



# Measuring the compliance of management system in manufacturing SMEs: An integrated model

Mario Biggeri<sup>a,b,c,\*</sup>, Leonardo Borsacchi<sup>b</sup>, Lisa Braitto<sup>d</sup>, Andrea Ferrannini<sup>a,b,c</sup>

<sup>a</sup> Department of Economics and Management, University of Florence, Via delle Pandette, 9, 50127, Florence, Italy

<sup>b</sup> ARCO (Action Research for CO-development) - PIN Srl, University of Florence, Piazza Giovanni Ciardi, 25 - 59100, Prato, Italy

<sup>c</sup> c.METOS, National University Centre on Applied Economic Studies, Via Voltapaletto, 11 - 44100 - Ferrara, Italy

<sup>d</sup> Department of Statistics, Computer Science, Applications "G. Parenti", University of Florence, Viale Morgagni, 59 - 50134, Florence, Italy

## ARTICLE INFO

Handling Editor: Cecilia Maria Villas Bôas de Almeida

### Keywords:

Sustainable production process  
Cleaner production  
Integrated management system  
Compliance index  
SMEs

## ABSTRACT

Research on the efficiency and sustainability of production systems has drawn attention to the importance of monitoring the social and environmental impacts of production processes and management systems. In particular, integrated models and tools need to be developed to assess the application of sustainable operations – especially in those sectors characterized by a high presence of SMEs.

This paper proposes an integrated assessment model – the Small and Medium Enterprise Compliance Assessment (SECA) – for SMEs involved in manufacturing and production. SECA provides an integrated tool to detect a firm's compliance with mandatory requirements on environmental and social issues in accordance with relevant legislation applicable in the country. This assessment model employs a new Index of Small and Medium Enterprise Compliance to synthesize both the levels of compliance and the complementary risks to which the enterprise is exposed to, given the applicable legislative domains.

To test the model, a pilot application was conducted based on the analysis of 99 Chinese-owned SMEs operating in the textile and fashion manufacturing district in Prato. These enterprises voluntarily underwent the assessment procedure to measure their compliance with mandatory processes and regulations.

The results that emerge from this pilot application demonstrate the relevance and capacity of SECA to assess and understand the degree of SMEs' compliance with relevant legislation on sustainability matters. The application also demonstrates the models' potential to be adapted to other local contexts and SMEs as required.

## 1. Introduction

The need to overcome unsustainable patterns of modern production and consumption has gained momentum in the last decade (Tukker et al., 2008; Bonilla et al., 2010; Roy and Singh, 2017; Wang et al., 2019). Research on government policies that fosters increased efficiency and sustainability of production systems (Nash, 2009; Honkasalo, 2011; Lehtoranta et al., 2011; Brizga et al., 2014; Schroeder, 2014; Almeida et al., 2015) has drawn attention to the importance of monitoring the social and environmental impacts of production activities. Firms play a leading role in the transition to sustainability due to the fact that their organizational structure, management system, and innovation processes

are all key drivers towards sustainability, inclusiveness, and productivity growth (Bocken et al., 2014; Amui et al., 2017; Geels, 2019). Therefore, appropriate models and tools<sup>1</sup> need to be developed to assess the application of sustainable operations, especially in those sectors characterized by a high presence of micro, small and medium enterprises (SMEs<sup>2</sup>). An organization is considered compliant with applicable regulations if it conforms to international and domestic laws, regulations, guidelines, and specifications relevant to its business processes. As outlined in the literature on SMEs (Jensen et al., 2001; Fabiano et al., 2004; Sørensen et al., 2007), obstacles to a firms' occupational health and safety performance include: limited human, economic and technological resources, low levels of managerial knowledge regarding the

\* Corresponding author. Department of Economics and Management, University of Florence, Via delle Pandette, 9, 50127, Florence, Italy.

E-mail addresses: [mario.biggeri@unifi.it](mailto:mario.biggeri@unifi.it) (M. Biggeri), [leonardo.borsacchi@pin.unifi.it](mailto:leonardo.borsacchi@pin.unifi.it) (L. Borsacchi), [lisa.braitto@unifi.it](mailto:lisa.braitto@unifi.it) (L. Braitto), [andrea.ferrannini@arcolab.org](mailto:andrea.ferrannini@arcolab.org) (A. Ferrannini).

<sup>1</sup> See, for instance, Corral (2003), Spangenberg et al. (2010), Dendler (2014), Dobes (2016), Jonkute and Staniskis (2016).

<sup>2</sup> In this regard, we embrace the definition of SMEs provided by the European Commission ([https://ec.europa.eu/growth/smes/sme-definition\\_it](https://ec.europa.eu/growth/smes/sme-definition_it)).

enterprise's risks, and deficiencies in organizational processes. Since compliance covers several dimensions (i.e., financial accounting, tax reporting, employment practices, health care billing, interactions with government officials, workplace health and safety, environmental protection, and more), regulatory noncompliance may represent risks for an organization, especially for the smallest ones (Coglianese and Nash, 2020). Moreover, violations of regulatory compliance often results in legal consequences. For this reason, entrepreneurs – especially in SMEs – tend to rely on the support of outside consultants and professionals (Oosthuizen et al., 2020).

Considering the current legislative fragmentation on sustainable production, it is necessary for SMEs to prioritize conducting internal compliance assessments specifically targeting integrated management systems.

To address this research gap, this paper proposes an integrated assessment model for SMEs involved in manufacturing and production: the small and medium enterprise compliance assessment (SECA). The SECA model provides an integrated tool to detect a firm's compliance with mandatory requirements on environmental and social issues in accordance with relevant legislation. This assessment model is comprised of an index – the Index of Small and Medium Enterprise Compliance (ISEC) – to synthesize the enterprises' levels of compliance as well as the related levels of risk to which they are exposed considering the main applicable legislative domains.

To test the SECA model, a case study research design was adopted (Yin, 2017). The pilot application of the SECA model is based on an analysis of Chinese-owned SMEs operating in the textile manufacturing district in Prato, Italy. These SMEs are characterized by high dynamism and low compliance of mandatory safety and taxation regulations (Borsacchi et al., 2016). Although there is a broad literature available on the Prato production system (Becattini, 2001; Smyth and French, 2009; Dei Ottati, 2014, 2018; Lan and Zhu, 2014; Lazzarotti and Capone, 2017; Ong and Freeman, 2017), limited attention has been given to the impacts of ethnic entrepreneurship in terms of the environmental and social sustainability of local production systems (Biggeri et al., 2015). It should be noted that the choice of this specific case study concerns an area – the Prato textile district – that is strongly characterized by the parcelling out of the production chain among small artisan enterprises. Moreover, at the time of the design of the SECA model, an extraordinary program of inspections was underway in the area with the aim of verifying compliance of Chinese-owned businesses.

The pilot sample for our study consisted of 99 ethnic Chinese-owned SMEs. These enterprises voluntarily underwent the SECA assessment procedure between September 2013 and September 2015 to measure their compliance with mandatory processes and regulations.

First of all, the application of the SECA model demonstrates its relevance and capacity to assess and understand the degree of SMEs' compliance with relevant legislation on sustainability matters. In addition, this initial application illustrates the potential for SECA to be adapted to other local contexts and SMEs as required. Second, the overall results that emerge from this application of the SECA model align with the findings from the parallel inspection activity carried out by local authorities. Moreover, the results of this specific case study draw the attention to the relevance of promoting socioeconomic integration, value chain linkages, and industrial collaborations between ethnic and native entrepreneurs as globalization and migration processes increasingly shape local economies.

The rest of the paper is divided as follows: Section 2 contains a literature overview of the debate on the sustainability of production processes. Section 3 illustrates the SECA model description, research design and data collection strategy, and the aggregation method for the ISEC. Section 4 offers an introduction on the case study selected for the pilot application of the model. Section 5 and Section 6 respectively present and discuss the results. Section 7 provides final remarks and avenues for future research.

## 2. Literature review

### 2.1. The debate on sustainable production

In the global framework outlined by the 2030 Agenda for Sustainable Development (UN, 2015), particular attention was drawn to the role of production processes within the context of the three dimensions of sustainability (environmental, social, and economic). The need to reform unsustainable patterns of modern-day production and consumption is widely acknowledged in the international debate (Tukker et al., 2008; Bonilla et al., 2010; Roy and Singh, 2017; Vinkhuyzen and Karlsson-Vinkhuyzen, 2014; EEA, 2018; Wang et al., 2019; Gupta et al., 2021). The goal is to foster a structural transformation of economies and societies towards sustainable human development (Ferrannini et al., 2021).

Extensive research conducted by an array of authors, including Bocken et al. (2014), Amui et al. (2017), and Geels (2019) among others, presents a central argument: firms should be considered leading actors in the transition to sustainability, not simply passive targets of public policies. The organizational structure, management system, and innovation processes of firms are all potential key drivers towards sustainability, inclusiveness, and productivity growth.

In line with this reasoning, literature has historically emphasized the need to develop appropriate models and tools to assess the application of sustainable operations (Corral, 2003; Spangenberg et al., 2010; Dendler, 2014; Dobes, 2016; Jonkute and Staniskis, 2016). This is particularly true in sectors characterized by a high presence of micro, small and medium enterprises. The textile industry is a prominent example, as analyzed by Niinimäki and Hassi (2011) in Finland, by Ortolano-Sanchez-Triana et al. (2014) in Pakistan, and by de Oliveira de Oliveira Neto et al. (2019) in the Sao Paulo State (Brazil).

A review of literature illuminates the various perspectives from which methods to evaluate sustainable production have been developed. For instance, Ramos et al. (2018) focus on environmental practices of sustainable managements (Karuppiyah et al., 2020), while Reinhold et al. (2015), Lindgreen et al. (2020), and Gupta et al. (2021) look at the social dimension of sustainable management. According to Droege et al. (2021), it is also essential to include circular economy principles in sustainability assessments. Similarly, Environmental, Social, and Governance (ESG) criteria represents widely diffused standards of a firm's behavior. ESG criteria refer specifically to key non-financial factors when measuring the sustainability and ethical impact of an investment in a business or company (Raneem et al., 2021).

In the last decade there was a rapid development and implementation of holistic approaches to risk management in enterprises. This illuminated the plethora of risks (such as the regulatory compliance, environmental, social issues, workplace health and safety) which all exist apart from the primary operational risk of the business itself. The consideration of all these various risks is known as Enterprise Risk Management - ERM (Djapic et al., 2013). ERM offers a significant contribution to the sustainable development of an organization as it incorporates the identification, measurement and management of risks directly related to sustainability (Shad et al., 2019).

### 2.2. Integrated management system towards sustainability

Sustainable production requires the continuous application of management systems to process products and services in order to improve efficiency and decrease risk for the environment, workers, and society.

As defined by ISO, a management system is a process used by organizations to set up and organize policies, objectives, and more. Management systems can address various topics including: environment, finance, quality, occupational health, and safety (ISO 9001, 2015). Rebelo et al. (2016) show that the integration of multiple management systems into a single system is a fusion of quality management, environmental management, occupational health & safety management,

corporate social responsibility management, and information security management systems, among others. In preparation to integrate management systems, organizations must take into account the level of correspondence and compatibility between the systems, as well as potential tangible and intangible benefits of integration (Rebello and Santos, 2012). According to Ramos et al. (2020), an organization's implementation of Integrated Management Systems (IMSs) is a strategic and operational decision that contributes to efficient functioning in terms of quality, environment, and occupational health & safety, and social responsibility (Domingues et al., 2016; Rebello et al., 2016). In particular, it improves the risk management and compliance with legal obligations as well as allows organizations to demonstrate to both the public and customers that they are fulfilling applicable legal requirements (Ramos et al., 2020). IMS reduces occupational hazards and accidents and simultaneously improves working conditions (Fernández-Muñiz et al., 2009). Additionally, IMS enhances productivity and leads to more effective usage of resources and an increased capability to deliver consistent services and products (Marhavilas et al., 2018; Barbosa et al., 2019). Rebello et al. (2016) argue that the adoption of an IMS is a strategic decision of relevant importance for the competitiveness and sustainability of organizations, as recognized by governments, employers and workers.

For this reason, many international standards and certifications (e.g., ISO 45001 or OHSAS, 18001, ISO 14001 and ISO 9001 standards) are widely implemented by organizations regardless of sector, size, location, or type, to demonstrate the effective planning, operation and control of management processes and their continuous improvement. Enterprises should identify and evaluate potential compliance risks following a 'plan-do-check-act' approach. In order to identify situations where noncompliance can occur, the organization should verify the application of compliance obligations with respect to the activities, products, services and relevant aspects of its operations (Wu and Liang, 2020). Nowadays, sustainability and circular economy principles also appear to be integrated into the implementation of environmental management systems based on ISO 14001 or Eco-Management and Audit Scheme (EMAS) directives (European Commission, 2017).

The integration of management systems, especially to implement international standards and certifications, must be embedded into the whole organizational culture. According to Jørgensen (2008) it is fundamental to consider the interrelations between operational areas as well as the internal and external context of enterprises in order to build a more holistic view regarding production and products.

### 2.3. Arguments to support SMEs' transition toward sustainable production

While large enterprises and Multinational Enterprises (MNEs) clearly deploy strong management and innovation capabilities (Fainshmidt et al., 2017), SMEs may often lack the resources and expertise to comply with sustainability requirements, deal with integrated management, and perform risk assessments (Klewitz and Hansen, 2014; Sørensen et al., 2007; Cagno et al., 2011; Caldera et al., 2019). According to Biggeri and Ferrannini (2014) this may hinder their contribution to sustainable human development within local production systems.

As argued by Ramos et al. (2020), extensive debate (Jensen et al., 2001; Fabiano et al., 2004; Sørensen et al., 2007; Barbosa et al., 2019) has pointed to limited human, economic, and technological resources as constraints to IMSs. Managers of SMEs may face internal time constraints to deal with sustainability requirements thus either relegating necessary actions to second place or completely externalising similar tasks (Hasle and Limborg, 2006; Hasle et al., 2012). Human resources (both management staff and production workers) within SMEs may not have the required knowledge or competences to assess risks and deal with various requirements in an integrated way. Cost and competition issues may affect SMEs' capacities to undertake necessary investments (e.g. on equipment and factory) in a timely manner, especially when

considering the relevant human and financial resources required for the implementation of a management system (Nunhes et al., 2017). Moreover, the management of compliance responsibilities has tended to grow more formal as the complexity of regulations has increased along with the complexity of business operations and transactions.

Nevertheless, the transition towards sustainable production processes and integrated management systems must be preliminarily based on SMEs' full compliance with mandatory legislation on workplace safety, environmental management, workers' rights, taxation and HR training.

For this reason, according to Ramos et al. (2020), SMEs need tailored support to develop strategies to achieve more sustainable production processes and adopt integrated management systems. On the one hand, public policies may deal with bureaucratic, administrative, and legislative simplification, as well as increase public investments and economic incentives (Bonafede et al., 2016; Haslam et al., 2016; Ramos et al., 2016, 2018). On the other hand, however, external advisory and intermediary support actions (e.g., by employers' association, trade unions, research centres) may contribute to increased knowledge, enhanced access to public funding, changed employers' attitude, and improved the company's safety culture.

However, a research gap is still evident. The need for integrated assessments of SMEs' sustainable production compliance is a central concern that deserves to be better analyzed and supported. Research that offers broad and integrated diagnoses of environmental impacts in conjunction with workplace safety and workers' rights issues may serve to drive management decision-making and support improvement at the organizational level, especially if conducted using synthetic and flexible instruments. Integrated assessments may also offer an interesting contribution to the theory of sustainable development and sustainable manufacturing and supply chains. Furthermore, the introduction of such instruments carries significant methodological and policy implications for both the private and public sectors.

## 3. The small and medium enterprise compliance assessment (SECA) model

### 3.1. Model

In consideration of this framework, we developed the SECA model to facilitate the assessment of compliance of SMEs' management systems within applicable laws and mandatory legislation. This model allows for the integrated assessment and promotion of ethical and productive rules as a crucial factor for the sustainability of local production systems and supply chains (Jonkute and Staniskis, 2016; Ramos et al., 2018) within the broader sustainable human development perspective (Biggeri and Ferrannini, 2014).

As depicted in Fig. 1, the SECA model is comprised of various steps. After the initial identification/selection of an SME or group of SMEs, the steps are as follows: (A) development, adaptation, and use of an integrated checklist assessing management system compliance of mandatory law and regulations, (B) assessment and evaluation using the application of the checklist of the enterprises regulatory compliance and risk management, (C) synthetization of the data collected through an aggregated index and the detection of intervention thresholds, (D) identification of noncompliance and risks as well as the implementation of targeted and customizable interventions through either (E) upgrading and improvement of firm's strategies or (F) applying local, sector-based, employer associations' interventions.

The objective of the SECA model is twofold: first, to identify possible non-compliances and risk exposure of enterprises' production processes with regard to relevant legal requirements (B in Fig. 1); and second, to help the enterprise understand weaknesses, non-compliances, and risks in the management system of its business activity and to devise possible interventions (D, E and F in Fig. 1).

In the event of non-compliance with legal requirements the

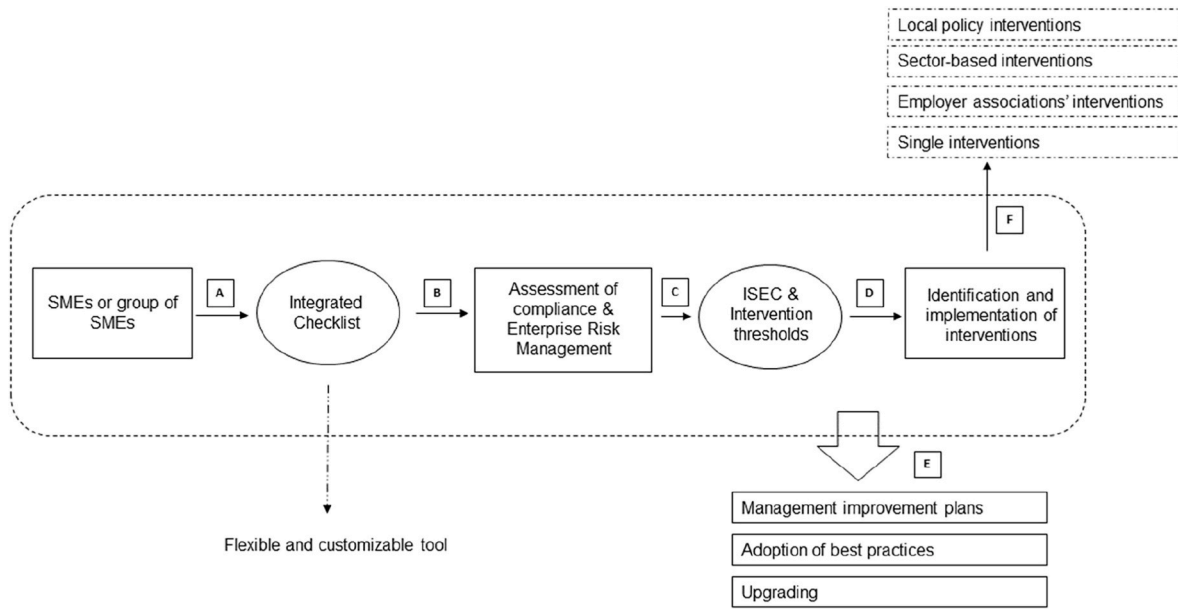


Fig. 1. Diagram of the SECA model. Source: authors' elaboration

enterprise may incur administrative sanctions once it has been inspected by the authorities. Sometimes, alongside deliberately fraudulent behavior by entrepreneurs, there is an element of unawareness regarding specific legislative requirements. As a result, noncomplying enterprises could be encouraged to improve internal procedures, upgrade internal management systems, and streamline business objectives (E and F in Fig. 1). Therefore, the SECA model should not only encourage SMEs' to upgrade by targeting single entrepreneurs, but it could be also applied as a research tool with the final objective being to develop tailored local policies as well as sector-based and employer associations' interventions (F in Fig. 1).

3.2. Research design, construction of the checklist and data collection

As described in section 3.1, the SECA model assesses the compliance of production processes management systems with specific focus on mandatory legislation. Compliance is verified using an integrated checklist consisting of evidence-based questions relating to applicable legislative requirements about workplace safety, environmental management, workers' rights, taxation and HR training.

At a methodological level, the construction of said checklist started from a collection and review of existing check-up instruments (more-or-less structured and documented) used by employer associations and

certification standards (ISO 9001, 2015, ISO 14001, 2015, ISO 45001, 2018). During the development of the checklist several meetings took place with consultants and professionals, each of whom were experts in one specific thematic area of business and compliance management (see Fig. 2).

It is important to note that traditional assessment approaches are often limited to specific thematic areas (e.g., safety, environment, taxation) and they are therefore unable to address compliance requirements in an integrated approach. Existing monothematic assessments and check-up systems involve frequent expert visits to the company and some requirements are requested several times by various consultants due to their overlap between the different areas. A non-integrated compliance assessment approach may be not fully effective (Borsacchi et al., 2014) if the implementation of various improvements and corrective actions that are not coordinated with each other in a vision of overall compliance. SMEs are particularly vulnerable to this lack of coordination. It is important to note that this often results in increased operational and bureaucracy costs.

The systematic integration of various field-mandatory requirements supports SMEs to upgrade their management systems towards sustainability by actively avoiding a piecemeal or silo-based approach which treat different dimensions, requirements and risks strictly separately (Rebelo et al., 2016).

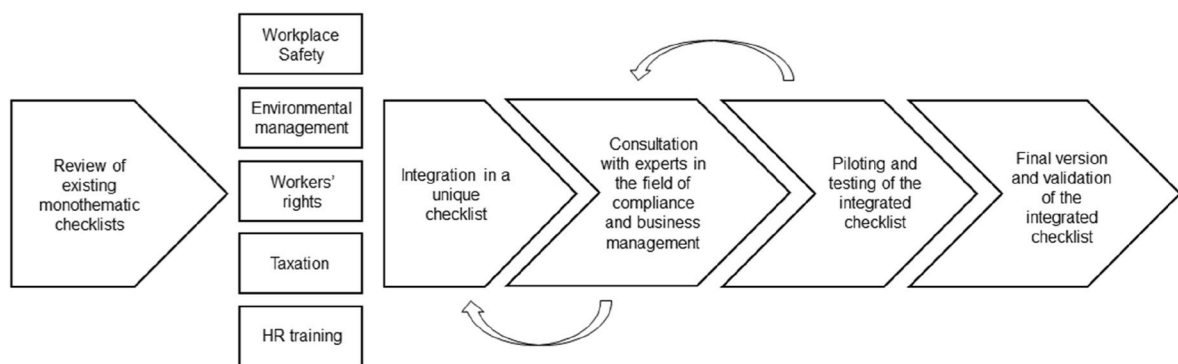


Fig. 2. Construction of the SECA checklist. Source: authors' elaboration

The version of the checklist integrated in the SECA model is the result of a careful process of validation which included a piloting and testing phase, through case study research design (Yin, 2017).

As typical of ISO audits, our integrated checklist is based on a rationalization of the mandatory requirements and their break-down into progressive levels of compliance. It consists of the three following parts: Part 1 – General information about the firm; Part 2 – Areas of management system of production processes (mandatory requirements); Part 3 – Direct observation.

Part 1 involves the collection of information regarding the activities and history of the enterprises. It aims at drawing a general picture of the business organization and management: company name, headquarter and production plants, legal representative, information on the plants, size of the market, turnover, number of employees, input and output markets, etc.

Part 2 is the technical core of the checklist. It includes several requirements across five identified main dimensions of compliance: workplace safety, environmental management, contracts and workers' rights, taxation, and training and information. Table 1 shows examples of requirements for each dimension. Requirements have been identified and formulated according to European and Italian legislation. The number and order of requirements in the checklist and the dimensions to which they belong can be adapted to suit context. For example, dimensions and requirements can be prioritized starting from those that, if disregarded, may cause health and safety hazards for workers and citizens (i.e., workplace safety and environmental management), followed by those for which lack of compliance does not result in immediate health and safety risks. Moreover, the set of requirements to be measured can be expanded by adding mandatory aspects specific to various production sectors. Equally, mandatory legislative elements or practices promoted by local stakeholders (e.g., the Chamber of Commerce, trade associations) may be added.

The degree of compliance is then checked on multiple levels (prerequisite, basic and intermediate).

A prerequisite is generally represented by documents of authorization whose absence would jeopardize lawful compliance. In the event of official controls by the authorities, failure to comply with a pre-requisite can result in significant consequences such as heavy penalties or the temporary closure of the business. The second level (basic) involves verifying the implementation of correct operational and management practices in accordance with the authorizations and documents indicated as pre-requisites. The third level (intermediate) involves providing objective evidence of the application of practices or rules outlined in official documents as previously specified at the prerequisite and basic levels. Full compliance is verified only if the requirements of each level are satisfied, otherwise compliance status is considered only partial or none. The enterprise needs to fulfil all stated requirements to be considered compliant with legislation.

After the checklist data has been collected during an in-person visit to the enterprises during Part 2, Part 3 consists of a list of requirements to be assessed through direct on-site observation in the enterprise's production premises. An external auditor evaluates each requirement as 'complete', 'adequate', 'not adequate'. An objective third-party observes the work environment in order to confirm what emerged at the document level.

For example: on the 'fire risk requirement' the assessment tool considers the following elements: the existence of a fire risk assessment document (prerequisite level); the validation of fire conformity by local authorities (basic level); operational evidence such as records to prove that firefighting equipment has been periodically inspected (intermediate level); and finally, direct third-party observation to verify that fire emergency signs are correctly applied and fire extinguishers are correctly signed and placed.

**Table 1**  
SECA model checklist.

Dimension	Examples of requirements
(i) Workplace safety	<ul style="list-style-type: none"> <li>- Safety risk assessment</li> <li>- Key person for workplace health and safety</li> <li>- Workers' representative for health and safety</li> <li>- Competent doctor</li> <li>- Conformity of electrical system</li> <li>- Conformity of grounding system</li> <li>- Safety of equipment and machinery</li> <li>- Individual protection devices</li> <li>- Chemical safety management</li> <li>- Fire risk</li> </ul>
(ii) Environmental management	<ul style="list-style-type: none"> <li>- Environmental authorizations</li> <li>- Air emissions</li> <li>- Wastewater management</li> <li>- Waste management</li> <li>- Waste register</li> <li>- Waste accounting</li> </ul>
(iii) Contracts and workers' rights	<ul style="list-style-type: none"> <li>- Number and features of associates, employees and collaborators</li> <li>- Number and features of employees of foreign nationality</li> <li>- Hiring of employees belonging to vulnerable groups</li> <li>- Contract categories</li> <li>- Work organization</li> <li>- Hiring official communications</li> <li>- Wages/salaries management</li> <li>- Territorial insurance position</li> <li>- Workplace accidents management</li> </ul>
(iv) Taxation	<ul style="list-style-type: none"> <li>- Balance sheet</li> <li>- Certificate of incorporation</li> <li>- VAT</li> <li>- Taxes paid in the last financial cycle</li> <li>- Special requirements in case of commercial activities for private consumers</li> <li>- Special requirements in case of commercial activities for other firms</li> <li>- Special requirements in case of commercial activities for foreign markets</li> <li>- Tax model declaration</li> </ul>
(v) Training and information	<ul style="list-style-type: none"> <li>- Compulsory training</li> <li>- Job training</li> <li>- Information</li> </ul>

*Note: (i) Main legislative references: Regulation (EC) No 1137/2008; D.lgs. 9 aprile 2008, n. 81 'Testo unico sulla salute e sicurezza sul lavoro'. Reference to standards: ISO 45001:2018 - Occupational health and safety management systems — Requirements with guidance for use; (ii) Main legislative references: Directive 2008/98/EC; D.lgs. 3 aprile 2006, n. 152 'Testo unico delle norme in materia di tutela ambientale e gestione dei rifiuti', Reference to standards: ISO 14001:2015 Environmental management systems — Requirements with guidance for use; (iii) Main legislative references: D.lgs. 27 giugno 2022, n. 104; D.lgs. 8 aprile 2003, n. 66; D.lgs. 26 marzo 2001, n. 151; D.lgs. 9 aprile 2008, n. 81; D.lgs. 26 maggio 1997, n. 152; Law 20 maggio 1970, n. 300. Reference to standards: ISO 45001:2018 - Occupational health and safety management systems — Requirements with guidance for use; SA8000 standard; (iv) Main legislative references: DPR 22 dicembre 1986, n. 917 'Testo Unico delle Imposte sui Redditi'; (v) Main legislative references: D.lgs. 9 aprile 2008, n. 81 'Testo unico sulla salute e sicurezza sul lavoro'. Reference to standards: ISO 45001:2018 - Occupational health and safety management systems — Requirements with guidance for use.*

Source: authors' elaboration

### 3.3. Construction of the index and intervention thresholds

Building on the integrated checklist and information collected in Part 2, the Index of Small and Medium Enterprise Compliance (ISEC) is introduced to measure overall compliance for each enterprise.

To begin with, we created an index for each of the five dimensions by aggregating the various requirements and taking into consideration the three levels into which all requirements are divided. Each level is assessed using the degree of compliance of the enterprises – non-compliant, partially compliant, or totally compliant – which resulted from checklist data. An enterprise can score between zero to 10 points for each requirement. We applied a ‘sequencing rule’: the level of basic requirement cannot be met without having first fulfilled the prerequisite level. Furthermore, we assigned a progressive weighting system for the three levels (i.e. the prerequisite level carries more weight than the basic, which in turn carries more than the intermediate). The arithmetic mean was chosen as the method of aggregation for the requirements in each dimension in order to allow for perfect substitutability among requirements. The dimension index does not assign different weighting to the requirements since the checklist assigns an equal importance.

The ISEC is obtained by aggregating the five dimensions – all of which are considered similarly weighted and using the Multidimensional Synthesis of Indicators (MSI) method (Mauro et al., 2018; Biggeri and Mauro, 2018; Biggeri et al., 2019; Biggeri and Ferrone, 2022).

Similar to the geometric mean aggregation method, the MSI method presents relevant properties including the ‘penalization’ of heterogeneity between achievements (see Appendix A in Biggeri et al., 2021). However, the MSI method overcomes the problems associated with the geometric mean method such as ‘over-penalization’ (Klugman et al., 2011). Considering the instrumental value of most dimensions, the MSI determines that a particularly low score in a specific dimension might not only cause an overall deprivation (intrinsic value) but also may negatively affect the other dimensions. For a more technical description and details on the construction of the MSI, see Mauro et al. (2018).

Applying the MSI, the ISEC formula is:

$$ISEC_i = 1 - \left[ \frac{1}{k} \sum_{j=1}^k (1 - x_{ij})^{g(x_i)} \right]^{\frac{1}{g(x_i)}}$$

where  $k$  is the total number of dimensions, and  $g(x_i)$  is a generic real-valued function of the  $i$ -th row of matrix  $X$ , with  $g(\bullet) \geq 1$  (to allow the convexity of the curves to the origin) (for details, see Mauro et al., 2018).

The ISEC can score between 0 and 1 with 1 representing ‘perfect compliance status’ and 0 ‘no compliance’. Thanks to the MSI aggregation method the ISEC considers both all dimensions to be equally important and heterogeneity in the scores obtained by each enterprise in each dimension. Indeed, the ISEC penalises those enterprises for which the indices’ scores across dimensions are highly heterogeneous. This penalization increases when the overall value of the different dimensions is lower and the results are more robust (see Biggeri et al., 2021 for properties and examples in the appendix A). In Appendix 1 in Supplementary Material we compare the results obtained through the MSI method to other classic methods of aggregation such as the arithmetic and geometric mean.

The SECA model, presented in the previous section, and the ISEC are inherently connected. Indeed, the SECA model draws attention to intervention thresholds identifying the level of risk to which the enterprise is exposed according to the results generated by the ISEC. Intervention thresholds determine the nature and severity of interventions needed when a certain level of noncompliance is assessed, and at the same time provide the necessary information to be assessed by Enterprise Risk Management.

The following Table 2 identifies the index thresholds and the severity of noncompliance in order to suggest the type of interventions needed on a normative basis.

The severity of noncompliance is considered with reference to both management and implied implications. The following is a practical example concerning fire risk prevention requirement.

The lack of fire extinguishers in the production premises and/or failure to check their functionality is a severe noncompliance, which

**Table 2**  
Intervention thresholds.

Threshold	Severity	Example/types of Intervention
≤0.5	Severe/high risk	Professional consulting, training, operational implementation or interventions
0.6–0.8	Moderate/moderate risk	Professional consulting and training
≥0.8	Mild/mild risk	Professional consulting

Source: authors’ elaboration

results in a high risk for the enterprise. This kind of noncompliance requires an intervention, for instance a documented period check of the functionality of fire extinguishers and their eventual purchase. The lack of specific fire risk training or an expired training certificate exemplifies a case of moderate noncompliance which requires registration for a training course for employees. A mild noncompliance in this case is the failure to update the fire risk plan of action included in the safety risk assessment document. To address this noncompliance the entrepreneur should consult a professional to update the documents.

To sum up, our research design described in the previous sections is fully incorporated in Fig. 3.

#### 4. Case study

For the pilot application of this novel model we rely on a case study research design (Yin, 2017). This is especially helpful in examining poorly understood phenomena in their natural settings and explicating processes related to ‘how’ research questions (Langley, 1999). A single case study is particularly fitting for our research goals. Our aim is not to validate hypotheses and build theories (for which multiple-case studies usually provide a more suitable setting), but to test and draw methodological insights to support the paths toward sustainability upgrading in manufacturing SMEs.

Our case study is the pilot application of this novel method and was carried out in the textile industrial district of Prato, Italy in 2013–2015.

The Prato industrial district has been extensively studied in previous literature (Becattini, 2001; Smyth and French, 2009; Dei Ottati, 2014, 2018; Lan and Zhu, 2014; Lazzarotti and Capone, 2017; Ong and Freeman, 2017). Prato counts more than 194,793 inhabitants, of which more than 26,389 are of Chinese origin and ethnicity (Comune di Prato, 2020). In 2019, Chinese entrepreneurship in Prato was characterized by 4,507 active firms in the textile, clothing, and leather sectors, representing approximately 57,40% of total firms in those sectors (Camera di Commercio Camera di Commercio di Prato, 2019). Most of these enterprises are characterized by low technological processes, low entrepreneur associations or trade union membership, high share of unpaid taxes, and substantial illegal money transfers to China. For these reasons, in 2015 local authorities launched an extraordinary plan of inspections for 4400 of the 7700 Chinese companies active in Prato, Empoli, Florence and Pistoia with a rate of inspections five times higher than that required by Italian national law. The goal of this ‘Lavoro Sicuro’ (Safe Work) plan, which was promoted and financed by the Tuscany Region, was to increase situations of regularity. Over the long-term official inspections have shown situations of irregularity mainly related to safety, hygienic conditions, and contractual regularity.<sup>3</sup>

The Prato case study is particularly relevant for the academic and policy debate for two main reasons. First, the centrality of industrial district and clusters within global value chains is undeniable (Gereffi and Lee, 2016), as place-based know how and collaboration mechanisms among local firms – mainly SMEs – still provide a remarkable

<sup>3</sup> Regional Project ‘Lavoro Sicuro’ (<https://www.regione.toscana.it/-/progetto-lavoro-sicuro>).

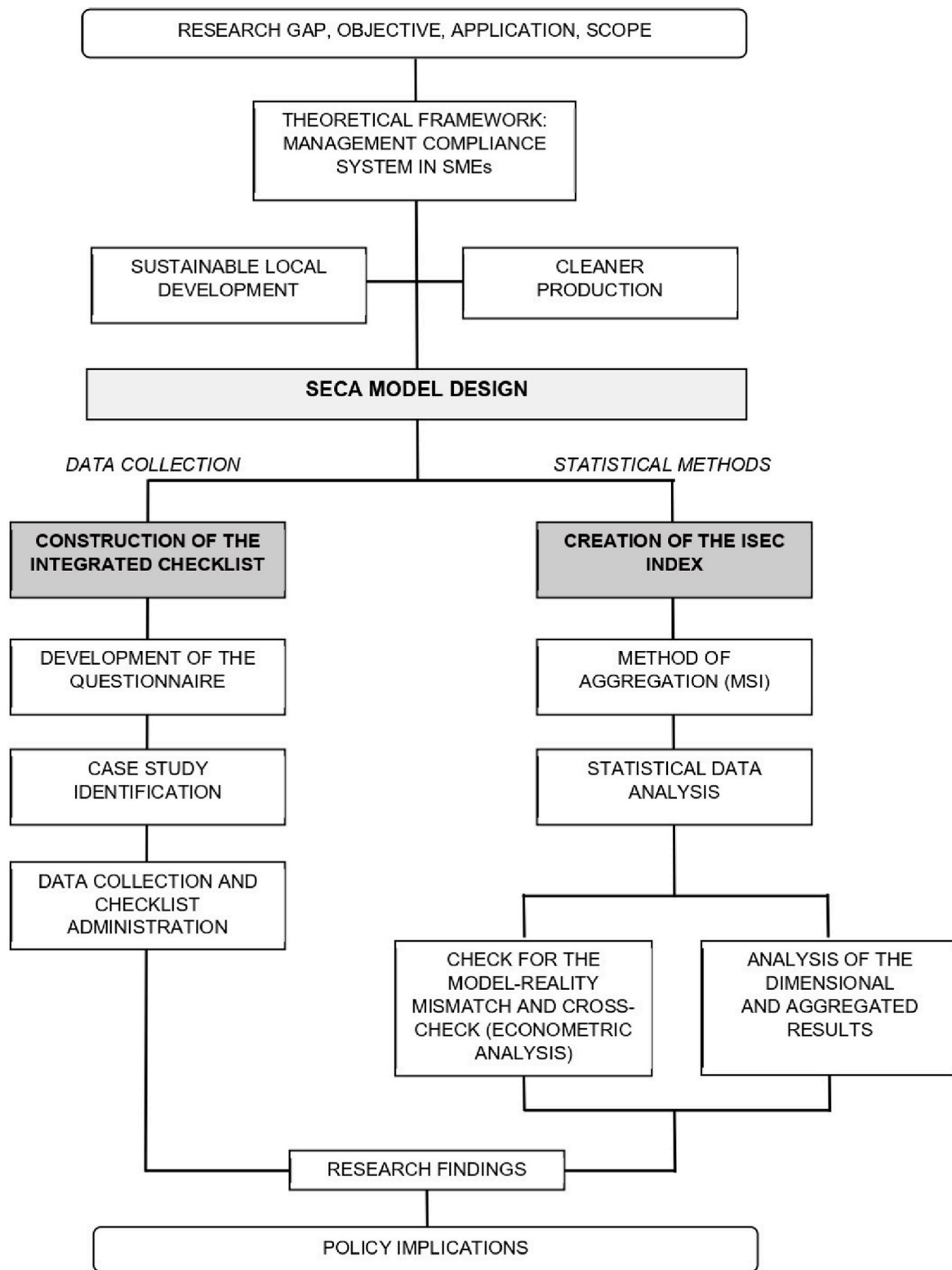


Fig. 3. Research design diagram.  
Source: authors' elaboration

value-added. Second, support for upgrading SMEs' production processes in industrial districts is a crucial policy area to promote sustainable development (Biggeri, 2020), especially in areas where increasing multiculturalism and high incidence of ethnic entrepreneurship characterize local economies due to globalization and migration processes. Third, all around the world the textile, clothing and leather sectors are

analyzed and targeted by policies to foster SMEs' upgrading processes towards efficiency and sustainability (Niinimäki and Hassi, 2011; OrtolanoSanchez-Triana et al., 2014; de Oliveira Neto et al., 2019). Lastly, at the local level the Municipality of Prato recently launched a comprehensive strategy called 'Prato Circular City' to foster circular economy transition within the city, especially within the textile district.

Issues such as environmental protection, cleaner production and innovation are the core agenda of this strategy.

The pilot application of the SECA model is not only directly applicable in Prato. The revealed insights and lessons are also valid and relevant for other industrial districts and the wider debate.

Given the industrial context, our research stemmed from the engagement with associations representing ethnic entrepreneurship in Prato, particularly Chinese-owned firms that are characterized by a high dynamism (Irpel, 2015) and widespread use of illegal work and non-compliant with safety and taxation (Dei Ottati, 2014). In particular, entrepreneurs and employers' associations expressed the need to assess the compliance of production processes with applicable laws and regulations in order to pursue improvement and build stronger relationships within the local community based on transparency and trust (Borsacchi et al., 2016). Beginning in 2013, local authorities, employers' associations, Chamber of Commerce, and research centres have joined efforts to provide tailored technical assistance to ethnic entrepreneurs. This has been based on the pilot application of the SECA model (through the adaptation of the checklist to detect firms' non-compliances with mandatory legislation in Italy) which required external auditors who have been purposively trained to support the management systems of productive processes by ethnic enterprises.

This approach enabled more than 140 companies of different sizes and from different sectors to trigger compliance and upgrading processes by suggesting corrective actions and improvements in their management systems towards sustainability.

The data collection and checklist tool administration in this particular case study was articulated in different procedural phases. The first phase consisted of initiating contact and starting a relationship with the enterprises selected in the sample. The enterprises were identified by connections with trade associations, consultants or professional practices in the area, and key 'leaders' of the business community. The second phase involved a back-office check of the enterprises, which included gathering the general characteristics of the company via the Chamber of Commerce registration, trade association, and information on the web. This desk work prepared for an easier and more effective administration of the checklist, for instance by eliminating requirements that were 'not relevant' to the specific enterprise. The last phase of the data collection consisted of a team of external auditors administering the questionnaire to the entrepreneurs.

The analysis reported in this paper is based on a sample of 99 ethnic Chinese-owned companies (out of a total of 102 enterprises originally selected, but three units were dropped owing to insufficient data) operating in the clothing sector in Prato's industrial district. These companies voluntarily underwent an assessment of their compliance with mandatory management regulations. The sample is not statistically representative of the entire population since the selection was based on voluntary involvement in our action-research, but it is useful for the purpose of testing the SECA model. The checklist was administered between September 2013 and September 2015.

The sample includes companies that mostly started their activities after 2012 (58%) (i.e., relatively new enterprises) and registered as individual enterprises (79.8%). The majority of the enterprises are SMEs (94.5% of the enterprises hire fewer than 15 workers). All the enterprises comprise part of the textile and clothing manufacturing sectors: 61.6% within the garment industry, with 10.10% being *pronto moda* (fast fashion) companies and 28.28% operating in other segments of the sector (knitwear, weaving, ironing, textile printing, etc.); 39% of the sample sell their output in the local market only, whereas over 33% also distribute abroad to both European and non-European markets.

As a first step, the checklist of the SECA model was carefully adapted and detailed according to mandatory legislation in Italy.

Data collection was conducted by administering the checklist in the form of a questionnaire that was filled by an external auditor who asked owners/managers to provide proof of documentation and authorizations as well as visited the enterprise premises for observational workplace

assessment (see for more detailed on the requirements [Table A2.1 in Supplementary Materials](#)). It is important to note that because the units of analysis in this case study are ethnic enterprises, the external auditors were not only trained on the content and technicalities of the checklist but also chosen to overcome cultural and potential language barriers.

After data collection and data cleaning, the compliance scores (ranging from zero to 10) were assigned, as reported in [Table 3](#).

Finally, for the sake of our analysis, we selected four dimensions out of five in the application of the methodology explained above. We decided to drop the fiscal dimensions (taxation) due to insufficient data. Indeed, in this specific context, the interviewed entrepreneurs rely completely on their accountants for matters concerning taxation and fiscal duties, thus their knowledge about such issues is often limited. Therefore, to avoid any bias, we decided not to consider the fiscal dimension while testing our approach and model, but we do consider this issue on the policy implications level.<sup>4</sup>

## 5. Results

This section presents the general results of the application of the SECA model and the calculation of ISEC in our case study. The complete results are reported in [Appendix 3 in Supplementary Material](#).

If we consider, on a normative basis, that an enterprise needs to score above 0.9 to be considered 'compliant', it can be observed that total compliance is quite low in this case study (see [Table 4](#) and [Fig. 4](#)).<sup>5</sup> Indeed, an enterprise with a score of 0.5344 is at the 75th percentile, which indicates that its ISEC score is higher than 75% of other scores. Moreover, a firm with a score of 0.379 is at the 50th percentile, meaning that its score is higher than 50% of all other scores. Only one enterprise scored above 0.9 (enterprise number 84) in the ISEC score.

From these results we can infer that the scores across the majority of the dimensions of the index are quite low. Indeed, the median of the sample is especially low, as is the mean. It is important to mention the particularly low score in the Workplace Safety Index, which calls for further elaboration. To better understand where the main problems lie in relation to compliance with workplace safety, we could disentangle the Workplace Safety Index and examine all individual requirements. Moreover, all this information could be integrated with the qualitative information gathered on the enterprises under analysis.

[Fig. 5](#) confirms the results commented on above since it shows the scores of each enterprise in the sample across the four dimensions compared with their aggregated ISEC scores for workplace safety index, environmental management, contracts and workers' rights, and training and information. The distribution of these scores around the aggregated score can be observed allowing us to detect which dimension(s) contributes to lowering or increasing it.

In order to understand if there are company factors that explain the diversity of compliance behaviors we also controlled the ISEC score for the type of economic activity of the enterprises in the textile and clothing sectors ([Fig. 6](#)).

Audited enterprises that are subject to environmental permits, such as dyeing plants or finishing mills, have a higher average in environmental management than others. This generally pushes the ISEC score further upward. There is also greater compliance in the workplace safety dimension for the same enterprises. It should be noted that in the same

<sup>4</sup> Concerning missing data (i.e., a response of 'do not know'), we selected requirements that had a percentage of missing data below 30%. For these requirements, we assigned a score for the missing data, since 'not knowing' or 'not verified' (NV) cannot be overlooked in the analysis. We assigned to NV a value that lies between 'noncompliant' and 'partially compliant' as it cannot be said that they are noncompliant, but the very fact of not having been able to verify their compliance status assumes a negative 'weight'.

<sup>5</sup> It is important to note that according to the Italian law an enterprise must be fully compliant (100%).

**Table 3**  
Table of scores.

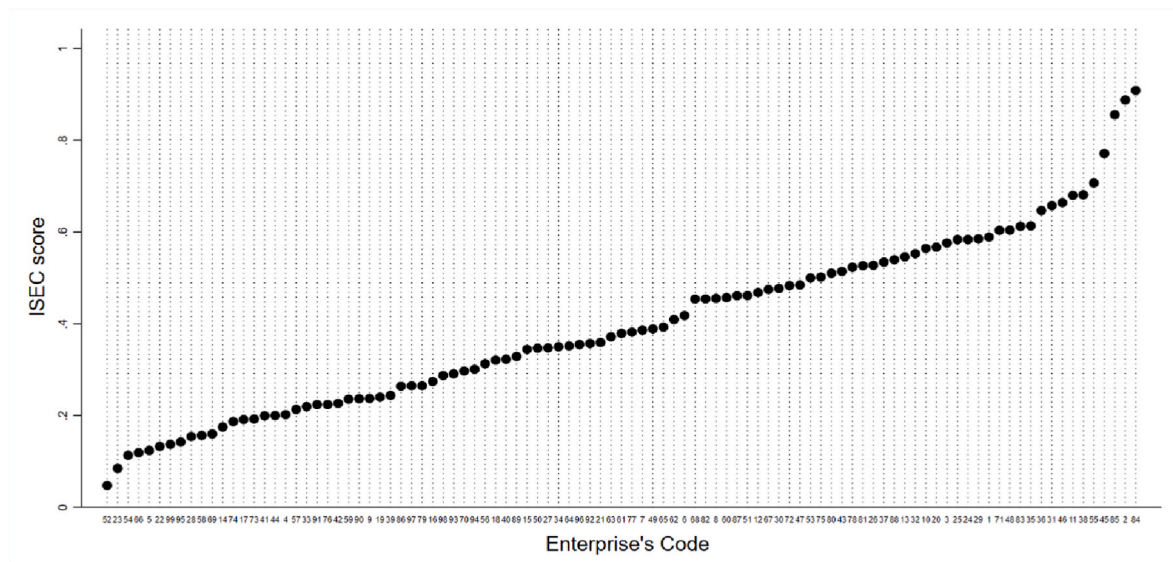
Prerequisite				Basic				Intermediate			
NC	NV/NS	PC	TC	NC	NV/NS	PC	TC	NC	NV/NS	PC	TC
0	1	2.5	5	5	5.5	7.5	8	8	8.5	9	10
If prerequisite does not exist, it is given as granted.				5	5.5	7.5	8	8	8.5	9	10

Note: NC = noncompliant, NV/NS = not verified/not known, PC = partially compliant, and TC = totally compliant.  
Source: authors' elaboration

**Table 4**  
Summary statistics.

	N	Mean	Std. Dev.	Min	Max	1st Perc.	25th Perc.	Median	75th Perc.	99th Perc.
Workplace safety index	99	.3499	.2243	.05	.97	.05	.1375	.3425	.4986	.97
Environmental management index	99	.3739	.2345	0	1	0	.2	.4	.5	1
Contracts and workers' rights index	99	.6193	.2139	.1583	1	.1583	.5	.6167	.7833	1
Training and information index	99	.4301	.3074	0	1	0	.2	.4	.64	1
ISEC score	99	.3972	.1894	.0474	.9084	.0474	.2361	.379	.5344	.9084

Source: authors' elaboration



**Fig. 4.** ISEC score for each enterprise of the sample.  
Source: authors' elaboration

time period the questionnaire was administered, local authorities launched targeted inspections of ethnic-run enterprises in Prato with the aim of verifying compliance with safety legislation. This led many companies to regularise their activities, either in response to the inspections by the authorities or in anticipation of being inspected. Lower scores are found mainly in the lower technology activities (i.e., clothing manufacturing and knitwear). These activities are characterized by strong dynamism, in terms of both setting up and shutting down, and are often led by enterprises that carry out activities on behalf of third parties.

Finally, to check for the model-reality mismatch and to cross-check whether the ISEC is a reliable and robust tool to represent the level of compliance and the risk to which the enterprise is exposed to, we econometrically analyzed which features of the enterprises influenced the ISEC score (see Table 5).

The results confirm our expectations that some factors influence having a higher score (e.g. having had an official authority inspection or having undergone some sensitization). For instance, larger enterprises (both in terms of production premises and workers) often have the resources to better comply with requirements (e.g., having the monetary

resources to hire consultants) thus resulting in higher scores of the index. Similarly, having received an inspection in the last 2 years or having already received some target awareness activity has a statistically significant positive impact on the score. As confirmed above, lower scores are found mainly in the lower technology activities, e.g., being a clothing manufacturing firms instead of a dyeing plant have a negative impact on the ISEC index.

### 6. Discussion on the SECA model

In the pilot application of our model using the case study of 99 Chinese-owned firms in Prato industrial districts, the ISEC score and the Dimensional indices are quite low – almost all fall below the severe intervention threshold. The alarming noncompliance of the sample was to be expected due to the particularity of our case study. Indeed, a large number of ethnic enterprises in Prato are characterized by low technological processes of production, extreme forms of exploitation of workers and high exposure to deep risks for their health and safety. In addition, there is diffused evidence of lawlessness both in terms of taxation and finance (Biggeri et al., 2014; Ong and Freeman, 2017).

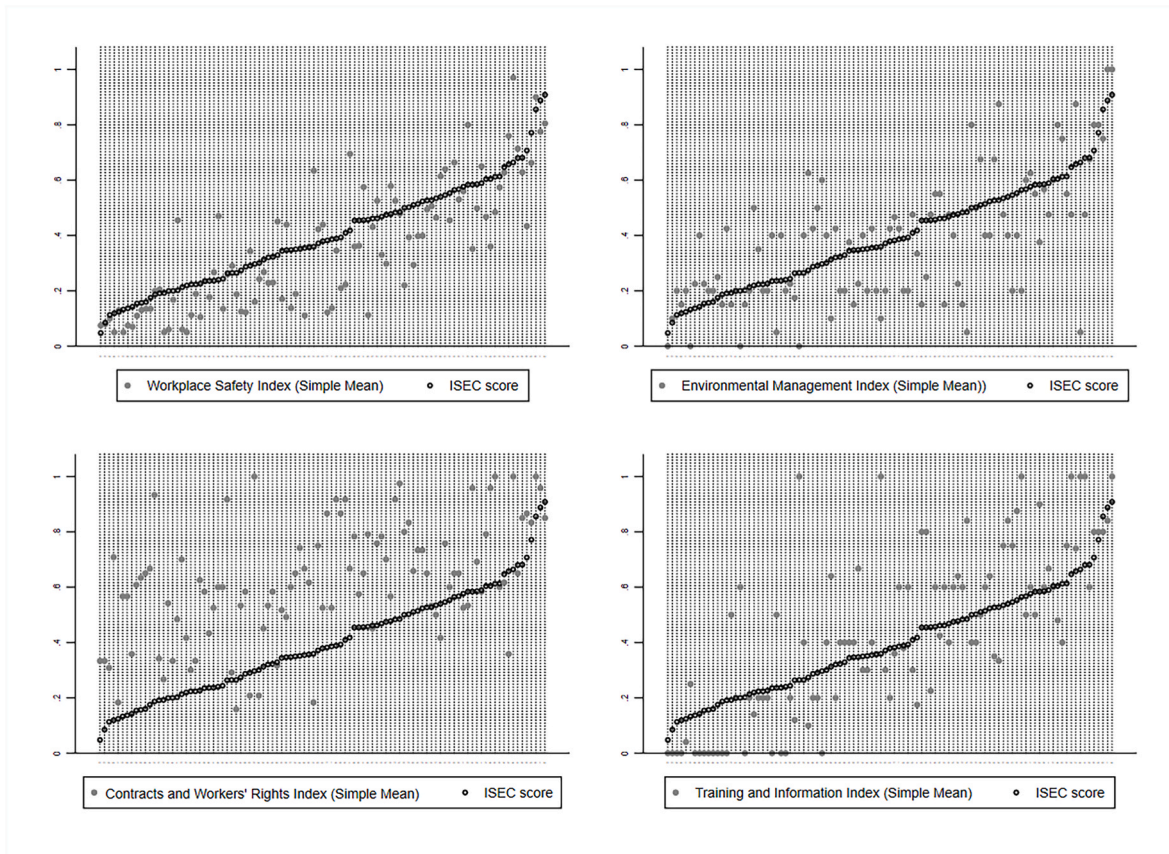


Fig. 5. Dimensional indices and ISEC score: a comparison. Note: on the vertical axis, the ISEC score and the Dimensional indices are portrayed; on the horizontal axis, all the enterprises in the sample are listed. Source: authors' elaboration

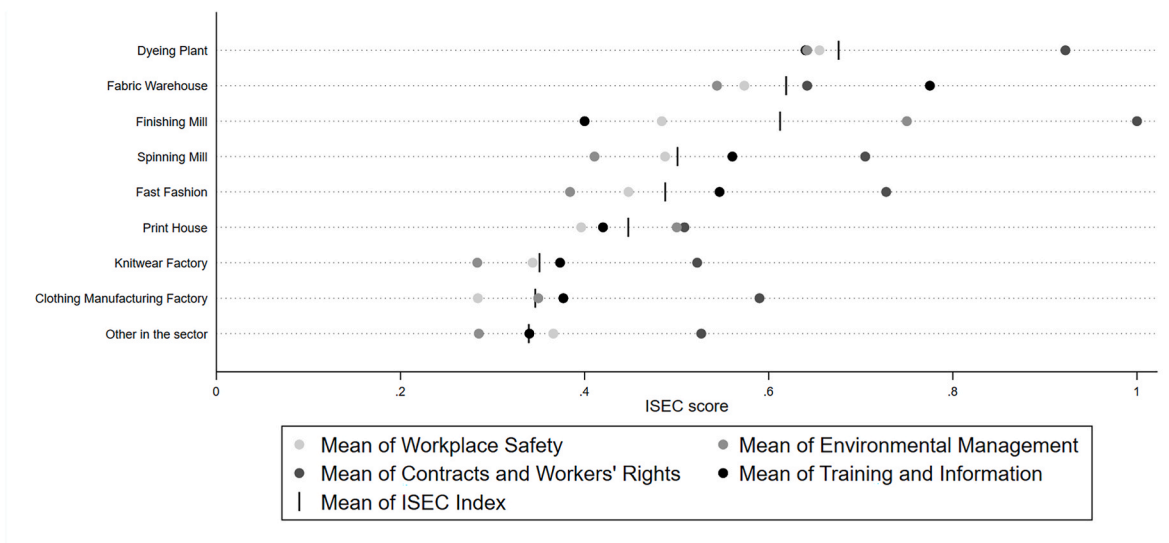


Fig. 6. Indices by type of activity in the textile and clothing sectors. Source: authors' elaboration

For these reasons, the implications and suggested interventions emerging from our results include the following actions: (1) On workplace safety: specific training for entrepreneurs ranging from the preparation of key required documents and the appointment of the compulsory persons responsible for safety to the actual implementation of all the measures of prevention and protection to ensure the safety of

factories and workers. (2) On environmental management: the level of knowledge and awareness was still low among Chinese entrepreneurs and new plans and training information tools became necessary. (3) Regarding contractual mandatory requirements: employers' associations play an important role since it appears necessary to stimulate entrepreneurs to rely on qualified professionals and consultants to avoid

**Table 5**  
OLS regression results.

	(1)	(2)	(3)
	ISEC	ISEC	ISEC
Business Longevity	.012* (.006)	.011 (.007)	.013* (.006)
Warehouse larger than 1000sqm	.162*** (.058)	.146*** (.055)	.149*** (.053)
Number of employees	.01** (.004)	.012*** (.004)	.012*** (.004)
Control from public authorities	.097** (.044)	.099** (.042)	.094** (.041)
Legal status: individual enterprise		.049 (.047)	.034 (.047)
Clothing manufacturing enterprise		-.084** (.039)	-.073* (.041)
Target Awareness activity			.074** (.037)
_cons	.239*** (.031)	.249*** (.07)	.214*** (.065)
Observations	71	71	71
R-squared	.377	.419	.455

Note: The independent variable is the ISEC index. The variable *Control from public authorities* is a dummy variable equal to 1 if the enterprise has undergone an inspection from public authorities in the last couple of years. The variable *Target Awareness activity* is a dummy variable equal to 1 if the enterprise has received some target awareness activity in the last couple of years. Standard errors are in parentheses \*\*\*p < .01, \*\*p < .05, \*p < .1. Source: authors' elaboration

remaining in a situation of complete ignorance of the contractual situation and taxation compliance of their company. It is necessary they remain constantly informed and keep copies of all documentation in order to increase internal management and good practices. (4) On the mandatory training area: professional consultancy and membership to employers' associations facilitate the constant and regular updating and training of the appointed persons with responsibilities for safety as well as contribute to the dissemination of good practices.

The results of this specific case study highlight the relevance of promoting socioeconomic integration, value chain linkages and industrial collaborations between ethnic and native entrepreneurs, especially in consideration of workers' rights and environmental concerns, as multiculturalism increasingly characterises local economies due to globalization and migration processes.

The SECA model was methodologically validated through its pilot application in Prato industrial district. In addition, it was institutionally validated as it paved the way for the creation of a customized responsible business certification for local enterprises operating in the textile sector (named *RBTtext*) at the provincial level.

The pilot application of the SECA model in the case study of Prato industrial district demonstrates its relevance, capacity, and appropriateness in assessing the compliance levels of management system of SMEs with mandatory legislation and regulation. SECA represents an interesting tool for both public institutions (e.g., local governments, inspection bodies) and private sector organizations (e.g., entrepreneurial associations, trade unions) interested in raising awareness of ethical and productive legislation among enterprises. The SECA model can be considered an enabling factor for the sustainability of manufacturing production chains as well as for entrepreneurs themselves to assess their compliance of mandatory requirements. Indeed, given the momentum to pursue the SDGs (UN, 2015) promoting sustainable human development and cleaner production at the local level (Biggeri and Ferrannini, 2014), the SECA model attempts to respond to the need to promote innovative and integrated management solutions – an argument strongly raised by Rebelo et al. (2016) – that facilitate the compliance of production processes with mandatory legislation. For instance, the integrated checklist presented here can be either a self-assessment tool for SMEs' owners/managers or a data collection tool

for employers' associations, trade unions, local institutions and research institutes and universities to assess the compliance status and related problems of a certain manufacturing sector or local system of production as a research tool for evidence-based policymaking.

Our pilot results deriving from the application of the SECA model and subsequent analysis of the ISEC bear numerous implications.

At a micro level, the SECA model can play an important role in the design and application of improvement and upgrading strategies for SMEs in their transition toward sustainable production, as also stressed by Depken and Zeman (2018). This integrated tool frames and places each enterprise in a process of management improvement and upgrading. This helps to define a plan for resolving existing noncompliance issues and tackling relevant risks in an ERM perspective. Moreover, information provided by SECA allows auditors to directly advise on specific operational issues without requiring entrepreneurs to seek for other specific expert advice (Borsacchi et al., 2014). This approach appears especially relevant for ethnic enterprises, as in the case of Prato industrial district. Meanwhile, external auditors can highlight the strengths and best practices already in place within enterprises.

At a meso, the aggregated results of the index allow inferences to be made regarding the entire local system of production (assuming the sampling is representative of the enterprises' population). Although the analysis is intended to assess the compliance status of each individual enterprise, the aggregated results provide a snapshot of the overall compliance status of SMEs within the broader sector, industrial cluster, or local system of production under analysis. This may pave the way for relevant policy implications concerning the design of public strategies and services steering the sustainability transition (Brizga et al., 2014).

As a starting point, in line with Wu and Liang (2020), it is necessary to enlighten entrepreneurs and the population as to their legal requirements and obligations towards sustainable development. New plans and training information tools are necessary, especially when the level of knowledge and awareness of environmental management and workplace safety is low. In addition, it is necessary to update the appointed persons who bear responsibility for safety, workers' rights, and environmental protection, as well as maintain regular training of all workers on mandatory measures to allow the dissemination of good practices.

Similar implications hold true both for the aggregated index as well as for the results regarding the scores in each dimension. For example, where our case study results flag a low average score in the Workplace Safety Index, public and private stakeholders might be encouraged to design strategies to ensure that SMEs upgrade their mandatory safety measures (Ramos et al., 2020). It also appears fundamental to enhance integration among organizations, services, and inspections across the different domains of workplace safety, environmental management, contracts and workers' rights, taxation, and training and information. This requires using a whole-of-government perspective to avoid a silo-based approach to SME improvement and upgrading in line with legislative requirements.

Over time, the application of the SECA model could enable the monitoring of progress at the enterprise level. Moreover, by comparing ISEC results gathered before and after the implementation of policy interventions, the SECA model could provide an evaluation of those public policies addressing the critical challenges of sustainability transition within local production systems.

## 7. Conclusions

Given the current global scenario, new solutions need to be devised to improve the sustainability and inclusiveness of production processes (Almeida et al., 2015). The SECA model presented and tested in this paper proves to be a relevant and appropriate tool to assess the integrated compliance of enterprises' management systems within mandatory legislation and regulations. This contributes to the improvement and upgrading processes of SMEs towards sustainability.

By offering a systematization and integration in a unique framework of requirements and their composition according to progressive levels of compliance, the SECA model determines whether enterprises effectively carry out sustainable operations and to what degree they are compliant. It also takes into consideration important societal concerns such as the well-being of workers and protection of the environment. Overall, the SECA model offers a fundamental preliminary step for SMEs wishing to develop and apply specific and in-depth approaches to improve sustainable processes and achieve cleaner and more inclusive production objectives.

The scientific contribution of this paper is mainly methodological, being based on the introduction of the SECA model and its implications on integrated management systems. The SECA model is an assessment model, together with a synthetic tool (i.e. the ISEC), to evaluate the compliance of management system. This ensures that the SECA model is applicable regardless of the type of industrial manufacturing sector and/or geographical location. The model and index can both be applied in various contexts because the checklist is customizable for individual enterprises, geographical locations, industrial sectors or local systems of production (i.e., industrial districts or industrial clusters). Although our research utilizes the typically required dimensions of interest for compliance status, the requirements included in the checklist may vary depending on local systems of production, industrial sectors and national legislation (see for instance [Table A2.1 in Appendix 2 in Supplementary Material](#) for requirements used in our case study).

This research contributes to the literature on sustainable production ([Wang et al., 2019](#)), especially on the topic of SMEs' transition toward sustainable operations and cleaner production ([Caldera et al., 2019](#)). It reinforces and adds evidence to the need for an integrated approach to management system, which is proved by the literature to lead to efficient functioning of the enterprises in terms of quality, environment, and occupational health & safety, and social responsibility ([Domingues et al., 2016](#); [Rebelo et al., 2016](#); [Ramos et al., 2020](#)). The SECA model encourages enterprises to evaluate the transition towards cleaner production in a more holistic manner – beyond just the profit focusing on regulation enforcement.

Some limitations of our pilot application of the SECA model can be highlighted. First of all, so far it has been piloted only on one case-study, which was characterized by some peculiarities related to ethnic firms undertaking a voluntary assessment of their management and production systems. Secondly, there is a visible trade-off between the sophistication and accessibility of the tool and index. The model, and in particular the checklist, take into consideration a large number of aspects which are required by the law. For this reason, some aspects that are important for the transition towards sustainable and cleaner production are excluded by the checklist and the model because they are not compulsory according to the current law and regulations. Thirdly, in our case study the complete questionnaire is law-dependent, and thus it could be outdated when referenced in the future.

For these reasons, future research should be conducted to expand and develop the testing and application of the SECA model and ISEC along three lines. First, by applying it in different industrial contexts to cross-check its functioning and to confirm its validity. Second, by applying it to a sample of native (non-ethnic) enterprises to compare different compliance performances and issues. Third, by testing the model and the index in completely different settings (in terms of location or sector) to assess its capacity to flexibly adapt and provide useful results at micro, meso and macro levels. Such a wide application of the SECA model and the ISEC would allow the determinants affecting compliance to be better understood, especially in regard to enterprise ownership, size, revenue, location, business longevity, employee competence, value chain linkages and industrial collaboration. This could influence the design of policy actions and strategies for cleaner, inclusive, and sustainable production systems at the international level. Moreover, integrated assessments and measurement may also offer an interesting contribution to the theory of sustainable local development

and sustainable manufacturing and supply chains.

Overall, future research along these lines would bolster academic and policymaking discussions with stronger evidence and analytical debate in the drive towards sustainable production processes across the world.

### CRedit authorship contribution statement

**Mario Biggeri:** Supervision, Project administration, Conceptualization, Methodology, Writing – original draft, Writing – review & editing. **Leonardo Borsacchi:** Project administration, Investigation, Conceptualization, Methodology, Resources, Visualization, Writing – original draft, Writing – review & editing. **Lisa Braito:** Formal analysis, Data curation, Visualization, Writing – original draft, Writing – review & editing. **Andrea Ferrannini:** Project administration, Investigation, Conceptualization, Methodology, Resources, Writing – original draft, Writing – review & editing. All the authors have contributed to the paper and agreed with the revised version. The corresponding author is responsible for ensuring that the descriptions are accurate and agreed by all authors.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Data availability

The data that has been used is confidential.

### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jclepro.2022.135297>.

### References

- Almeida, C.M.V.B., Agostinho, F., Giannetti, B.F., Huisingh, D., 2015. Integrating cleaner production into sustainability strategies: an introduction to this special volume. *J. Clean. Prod.* 96, 1–9.
- Amui, L.B.L., Jabbour, C.J.C., de Sousa Jabbour, A.B.L., Kannan, D., 2017. Sustainability as a dynamic organizational capability: a systematic review and a future agenda toward a sustainable transition. *J. Clean. Prod.* 142 (1), 308–322.
- Barbosa, C., Azevedo, R., Rodrigues, M.A., 2019. Occupational safety and health performance indicators in SMEs: a literature review. *Work: J. Prev. Assess. Rehabil.* 64 (2), 217–227.
- Becattini, G., 2001. The Caterpillar and the Butterfly. An Exemplary Case of Development in the Italy of the Industrial Districts. Felice Le Monnier, Firenze.
- Biggeri, M., 2020. Industrial clusters in BRICS countries: a sustainable human development perspective. In: Anand, P.B., Comim, F., Fennell, S. (Eds.), *Handbook of BRICS and Emerging Economies*. Oxford University Press, Oxford.
- Biggeri, M., Ferrannini, A., 2014. *Sustainable Human Development: A New Territorial and People-Centred Perspective*. Springer.
- Biggeri, M., Ferrone, L., 2022. Child sustainable human development index (CSHDI): monitoring progress for the future generation. *Ecol. Econ.* 192, 107266 <https://doi.org/10.1016/j.ecolecon.2021.107266>.
- Biggeri, M., Mauro, V., 2018. Towards a more 'sustainable' human development index: integrating the environment and freedom. *Ecol. Indic.* 91, 220–231.
- Emersione, sviluppo. In: Biggeri, M., Borsacchi, L., Ferrannini, A., Ferrara, F., Grassi, C. (Eds.), 2015. *Integrazione nel Territorio Pratese: Un Modello di Sensibilizzazione e Accompagnamento*. Ricerca. Pacini Editore, Pisa.
- Biggeri, M., Clark, D.A., Ferrannini, A., Mauro, V., 2019. Tracking the SDGs in an 'integrated' manner: a proposal for a new index to capture synergies and trade-offs between and within goals. *World Dev.* 122, 628–647.
- Biggeri, M., Bortolotti, L., Mauro, V., 2021. The analysis of well-being using the income-adjusted multidimensional synthesis of indicators: the case of China. *Rev. Income Wealth* 67 (3), 684–704.
- Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. *J. Clean. Prod.* 65, 42–56.
- Bonafede, M., Corfiati, M., Gagliardi, D., Boccuni, F., Ronchetti, M., Valenti, A., Iavicoli, S., 2016. OHS management and employers' perception: differences by firm size in a large Italian company survey. *Saf. Sci.* 89, 11–18.

- Bonilla, S.H., Almeida, C.M.V.B., Giannetti, B.F., Huisingh, D., 2010. The roles of cleaner production in the sustainable development of modern societies: an introduction to this special issue. *J. Clean. Prod.* 18, 1–5.
- Borsacchi, L., Biggeri, M., Ferrannini, A., 2016. Application and review of an integrated checklist to promote legal compliance and socially responsible behaviors among ethnic enterprises. In: 20<sup>th</sup> IGWT Symposium, Commodity Science in a Changing World. Science and Economics, Varna, Bulgaria, September 12–16<sup>th</sup> 2016, pp. 733–740.
- Brizga, J., Mishchuk, Z., Golubovska-Onisimova, A., 2014. Sustainable consumption and production governance in countries in transition. *J. Clean. Prod.* 63, 45–53.
- Cagno, E., Micheli, G.J., Perotti, S., 2011. Identification of OHS-related factors and interactions among those and OHS performance in SMEs. *Saf. Sci.* 49 (2), 216–225.
- Caldera, H.T.S., Desha, C., Dawes, L., 2019. Evaluating the enablers and barriers for successful implementation of sustainable business practice in 'lean'SMEs. *J. Clean. Prod.* 218, 575–590.
- Camera di Commercio di Prato, 2019. Demografia delle imprese. <http://www.po.camcom.it/servizi/datistud/index.php>. (Accessed 21 April 2021).
- Coglianesi, C., Nash, J., 2020. Compliance management systems: do they make a difference? Cambridge Handbook of Compliance (D. Daniel Sokol & Benjamin van Rooij eds., Cambridge University Press, Forthcoming), U of Penn, Inst for Law & Econ Research Paper 20–35.
- Comune di Prato, 2020. Prato conta a cura dell'Ufficio di Statistica. <http://statistica.comune.prato.it/>. (Accessed 21 April 2021).
- Corral, C.M., 2003. Sustainable production and consumption systems-cooperation for change: assessing and simulating the willingness of the firm to adopt/develop cleaner technologies. The case of the In-Bond industry in northern Mexico. *J. Clean. Prod.* 11 (4), 411–426.
- de Oliveira Neto, G.C., Ferreira Correia, J.M., Silva, P.C., de Oliveira Sanches, A.G., Lucato, W.C., 2019. Cleaner production in the textile industry and its relationship to sustainable development goals. *J. Clean. Prod.* 228, 1514–1525.
- Dei Ottati, G., 2014. A transnational fast fashion industrial district: an analysis of the Chinese businesses in Prato. *Camb. J. Econ.* 38 (5), 1247–1274. <https://doi.org/10.1093/cje/beu015>.
- Dei Ottati, G., 2018. Marshallian industrial districts in Italy: the end of a model or adaptation to the global economy? *Camb. J. Econ.* 42 (2), 259–284.
- Dendler, L., 2014. Sustainability meta labelling: an effective measure to facilitate more sustainable consumption and production? *J. Clean. Prod.* 63, 74–83.
- Depken, D., Zeman, C., 2018. Small business challenges and the triple bottom line, TBL: needs assessment in a Midwest State, USA. *Technol. Forecast. Soc. Change* 135, 44–50.
- Djapic, M., Popovic, P., Lukic, L., 2013. Integration of the technical product risk assessment within the ISO 31000 enterprise risk management concept. *Adv. Mater. Res.* 633, 263–276 (Trans Tech Publications Ltd).
- Dobes, V., 2016. An integrated diagnostic tool for identifying and quantifying the opportunities for sustainable consumption and production in industry. *J. Clean. Prod.* 135, 567–576.
- Domingues, P., Sampaio, P., Arezes, P.M., 2016. Integrated management systems assessment: a maturity model proposal. *J. Clean. Prod.* 124, 164–174.
- Droegge, H., Ramos, T.B., Raggi, A., Kircherr, J., 2021. Navigating through the emerging paths of organizational assessment: the relationship between sustainability and circular economy assessment. In: The 27<sup>th</sup> Annual Conference, International Sustainable Development Research Society, Accelerating the Progress towards the 2030 SDGs in Times of Crisis. Östersund, Sweden. July 13–15 2021.
- European Commission, 2017. Moving towards a Circular Economy with EMAS Best Practices to Implement Circular Economy Strategies (With Case Study Examples).
- European Environment Agency (EEA), 2018. Perspectives on Transitions to Sustainability. EEA Report. No 25/2017. Publications Office of the European Union, Luxembourg. <https://doi.org/10.2800/332443>.
- Fabiano, B., Curro, F., Pastorino, R., 2004. A study of the relationship between occupational injuries and firm size and type in the Italian industry. *Saf. Sci.* 42 (7), 587–600.
- Fainshmidt, S., Nair, A., Mallon, M.R., 2017. MNE performance during a crisis: an evolutionary perspective on the role of dynamic managerial capabilities and industry context. *Int. Bus. Rev.* 26 (6), 1088–1099.
- Fernández-Muñiz, B., Montes-Peón, J.M., Vazquez-Ordás, C.J., 2009. Relation between occupational safety management and firm performance. *Saf. Sci.* 47 (7), 980–991.
- Ferrannini, A., Barbieri, E., Biggeri, M., Di Tommaso, M.R., 2021. Industrial policy for sustainable human development in the post-Covid19 era. *World Dev.* 137, 105215 <https://doi.org/10.1016/j.worlddev.2020.105215>.
- Geels, F.W., 2019. Socio-technical transitions to sustainability: a review of criticisms and elaborations of the multi-level perspective. *Curr. Opin. Environ. Sustain.* 39, 187–201.
- Gereffi, G., Lee, J., 2016. Economic and social upgrading in global value chains and industrial clusters: why governance matters. *J. Bus. Ethics* 133 (1), 25–38.
- Gupta, H., Kumar, A., Wasan, P., 2021. Industry 4.0, cleaner production and circular economy: an integrative framework for evaluating ethical and sustainable business performance of manufacturing organizations. *J. Clean. Prod.* 295, 126253.
- Haslam, C., O'Hara, J., Kazi, A., Twumasi, R., Haslam, R., 2016. Proactive occupational safety and health management: promoting good health and good business. *Saf. Sci.* 81, 99–108.
- Hasle, P., Limborg, H.J., 2006. A review of the literature on preventive occupational health and safety activities in small enterprises. *Ind. Health* 44 (1), 6–12.
- Hasle, P., Kvorning, L.V., Rasmussen, C.D., Smith, L.H., Flyvholm, M.A., 2012. A model for design of tailored working environment intervention programmes for small enterprises. *Saf. Health Work* 3 (3), 181–191.
- Honkasalo, A., 2011. Perspectives on Finland's sustainable consumption and production policy. *J. Clean. Prod.* 19 (16), 1901–1905.
- IRPET, 2015. Relazioni locali e transnazionali delle imprese cinesi di Prato e loro contributo all'economia della provincia. Istituto Regionale Programmazione Economica Toscana, Firenze.
- ISO 14001, 2015. Environmental Management Systems e Requirements. International Organization for Standardization, Geneva.
- ISO 45001, 2018. Occupational Health and Safety Management Systems e Requirements with Guidance for Use. International Organization for Standardization, Geneva.
- ISO 9001, 2015. Quality Management Systems e Requirements. International Organization for Standardization, Geneva.
- Jensen, P.L., Alstrup, L., Thoft, E., 2001. Workplace assessment: a tool for occupational health and safety management in small firms? *Appl. Ergon.* 32 (5), 433–440.
- Jonkute, G., Staniskis, J.K., 2016. Realising sustainable consumption and production in companies: the SUSTainable and RESponsible COMPany (SURESOCOM) model. *J. Clean. Prod.* 138, 170–180.
- Jørgensen, T.H., 2008. Towards more sustainable management systems: through life cycle management and integration. *J. Clean. Prod.* 16 (10), 1071–1080.
- Karuppiah, K., Sankaranarayanan, B., Ali, S.M., Chowdhury, P., Kumar Paul, S., 2020. An integrated approach to modeling the barriers in implementing green manufacturing practices in SMEs. *J. Clean. Prod.* 265, 121737.
- Klewitz, J., Hansen, E.G., 2014. Sustainability-oriented innovation of SMEs: a systematic review. *J. Clean. Prod.* 65, 57–75.
- Klugman, J., Rodríguez, F., Choi, H.J., 2011. The HDI 2010: new controversies, old critiques. *J. Econ. Inequal.* 9, 249–288. <https://doi.org/10.1007/s10888-011-9178-z>.
- Lan, T., Zhu, S., 2014. Chinese apparel value chains in Europe: low-end fast fashion, regionalization, and transnational entrepreneurship in Prato, Italy. *Eurasian Geogr. Econ.* 55 (2), 156–174. <https://doi.org/10.1080/15387216.2014.948471>.
- Langley, A., 1999. Strategies for theorizing from process data. *Acad. Manag. Rev.* 24, 691–710.
- Lazzeretti, L., Capone, F., 2017. The transformation of the Prato industrial district: an organisational ecology analysis of the co-evolution of Italian and Chinese firms. *Ann. Reg. Sci.* 58, 135–158. <https://doi.org/10.1007/s00168-016-0790-5>.
- Lehtoranta, S., Nissinen, A., Mattila, T., Melanen, M., 2011. Industrial symbiosis and the policy instruments of sustainable consumption and production. *J. Clean. Prod.* 19 (16), 1865–1875.
- Lindgreen, E.R., Salamone, R., Reyes, T., 2020. Measuring circular economy at the micro level: is the social dimension included?. In: *Le scienze merceologiche nell'era 4.0. XXIX Congresso Nazionale di Scienze Merceologiche*. Salerno, Italy. 13-14 February 2020, pp. 396–403. Esposito et al.
- Marhavilas, P., Koulouriotis, D., Nikolaou, I., Tsotoulidou, S., 2018. International occupational health and safety management-systems standards as a frame for the sustainability: mapping the territory. *Sustainability* 10 (10), 3663.
- Mauro, V., Biggeri, M., Maggino, F., 2018. Measuring and monitoring poverty and well-being: a new approach for the synthesis of multidimensionality. *Soc. Indic. Res.* 135 (1), 75–89.
- Nash, H.A., 2009. The European Commission's sustainable consumption and production and sustainable industrial policy action plan. *J. Clean. Prod.* 17 (4), 496–498.
- Niinimäki, K., Hassi, L., 2011. Emerging design strategies in sustainable production and consumption of textiles and clothing. *J. Clean. Prod.* 19 (16), 1876–1883.
- Nunhes, T.V., Barbosa, L.C.F.M., de Oliveira, O.J., 2017. Identification and analysis of the elements and functions integrable in integrated management systems. *J. Clean. Prod.* 142, 3225–3235.
- Ong, X., Freeman, S., 2017. Understanding Chinese immigrants in Prato's industrial district: benefits to local entrepreneurs. In: Guercini, S., Dei Ottati, G., Baldassar, L., Johanson, G. (Eds.), *Native and Immigrant Entrepreneurship*. Springer, Cham. [https://doi.org/10.1007/978-3-319-44111-5\\_11](https://doi.org/10.1007/978-3-319-44111-5_11).
- Oosthuizen, A., Van Vuuren, J., Botha, M., 2020. Compliance or management: the benefits that small business owners gain from frequently sourcing accounting services. *Southern African J. of Entrepreneurship and Small Bus. Manag.* 12 (1), 330. <https://doi.org/10.4102/sajesbm.v12i1.330>.
- Ortolano, L., Sanchez-Triana, E., Afzal, J., Ali, C.L., Rebellón, S.A., 2014. Cleaner production in Pakistan's leather and textile sectors. *J. Clean. Prod.* 68, 121–129.
- Ramos, D., Arezes, P., Afonso, P., 2016. Application of the Delphi Method for the inclusion of externalities in occupational safety and health analysis. *Dyna* 83 (196), 14–20.
- Ramos, A.R., Ferreira, J.C.E., Kumar, V., Garza-Reyes, J.A., Cherrafi, A., 2018. A lean and cleaner production benchmarking method for sustainability assessment: a study of manufacturing companies in Brazil. *J. Clean. Prod.* 177, 218–231.
- Ramos, D., Afonso, P., Rodrigues, M.A., 2020. Integrated management systems as a key facilitator of occupational health and safety risk management: a case study in a medium sized waste management firm. *J. Clean. Prod.* 262, 121346.
- Raneem, K., Heba, A., Ehab, K.A.M., 2021. The Sustainable Development Goals and corporate sustainability performance: mapping, extent and determinants. *J. Clean. Prod.* 311, 127599.
- Rebelo, M.F., Santos, G., 2012. Integration of the occupational health and safety management system with the quality management system and environmental management system: From the theory to the action. In: *Book of Abstracts of the International Symposium on Occupational Safety and Hygiene SHO 2012*. Minho University, pp. 372–374. March 9-10.
- Rebelo, M.F., Santos, G., Silva, R., 2016. Integration of management systems: towards a sustained success and development of organizations. *J. Clean. Prod.* 127, 96–111.
- Reinhold, K., Järvis, M., Tint, P., 2015. Practical tool and procedure for workplace risk assessment: evidence from SMEs in Estonia. *Saf. Sci.* 71, 282–291.

- Roy, V., Singh, S., 2017. Mapping the business focus in sustainable production and consumption literature: review and research framework. *J. Clean. Prod.* 150, 224–236.
- Schroeder, P., 2014. Assessing effectiveness of governance approaches for sustainable consumption and production in China. *J. Clean. Prod.* 63, 64–73.
- Shad, M.K., Lai, F.W., Fatt, C.L., Klimes, J.J., Bokhari, A., 2019. Integrating sustainability reporting into enterprise risk management and its relationship with business performance: a conceptual framework. *J. Clean. Prod.* 208, 415–425.
- Smyth, G.J.R., French, R., 2009. *Living outside the Walls: the Chinese in Prato*. Cambridge Scholars Publishing.
- Sørensen, O.H., Hasle, P., Bach, E., 2007. Working in small enterprises—is there a special risk? *Saf. Sci.* 45 (10), 1044–1059.
- Spangenberg, J.H., Fuad-Luke, A., Blincoe, K., 2010. Design for Sustainability (DFS): the interface of sustainable production and consumption. *J. Clean. Prod.* 18 (15), 1485–1493.
- Tukker, A., Emmert, S., Charter, M., Vezzoli, C., Sto, E., Andersen, M.M., Geerken, T., Tischner, U., Lahlou, S., 2008. Fostering change to sustainable consumption and production: an evidence-based view. *J. Clean. Prod.* 16 (11), 1218–1225.
- UN, 2015. *Transforming our world: the 2030 agenda for sustainable development*. Resolution adopted by the General Assembly of the United Nations (A/RES/70/1), New York 1–35.
- Vinkhuyzen, O.M., Karlsson-Vinkhuyzen, S.I., 2014. The role of moral leadership for sustainable production and consumption. *J. Clean. Prod.* 63, 102–113.
- Wang, C., Ghadimi, P., Lim, M.K., Tseng, M.L., 2019. A literature review of sustainable consumption and production: a comparative analysis in developed and developing economies. *J. Clean. Prod.* 206, 741–754.
- Wu, X., Liang, H., 2020. Exploration research on the model of government regulation based on compliance management system. In: *2020 6th International Conference on Information Management (ICIM)*. IEEE, pp. 117–121.
- Yin, R.K., 2017. *Case Study Research: Design and Methods*, fifth ed. SAGE.