

Article

Green Sourcing: Supplier Assessment and Selection Practices across Industries

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Abstract: *Background:* Over the last years, the assessment and selection of suppliers, based on the environmental performance of their products/services and their operations, has reached paramount importance and attracted the interest of many researchers and practitioners. Based on the prevailing perspective of supplier selection as a purely decision-making problem, this interest has been channeled towards the development of decision-support methods and tools. Other broader issues, such as whether there are converging or diverging green supplier evaluation and selection organizational processes across industries has not been addressed. *Methods:* Here, for the first time, we address this question by adopting a systems perspective and by considering green supplier evaluation and selection as an organizational sub-process of the broader sourcing process. We use activity theory to represent green supplier evaluation and selection as two interconnected activities, each comprising a set of organizational practices. Based on this representation, we developed a research instrument to carry out empirical research in a sample of 80 companies from five industries (pharmaceuticals, food processing, aquaculture, construction materials, waste management and recycling) in Greece. *Results:* The results of the survey suggest that green supplier evaluation and selection practices do not fully converge, but there are differences across industries. *Conclusions:* The cultural and historical context of industries influences the adoption of specific environmental supplier evaluation and selection practices.

Keywords: green procurement; environmental supplier evaluation; environmental supplier selection; activity theory; CHAT; industry context; Greece



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1. Introduction

Recently, Green Supply Chain Management (GSCM) has emerged as an important dimension of Environmental, Social and Governance (ESG) strategic initiatives of organizations [1]. GSCM concerns the sustainability of a wide range of activities along the value chain, including design and new product development, sourcing, manufacturing, packaging, distribution, as well as activities related to human/social issues, such as the health and safety of employees and customers [2,3]. As a direct or indirect determinant of the environmental performance of the rest of the chain's activities downstream, the upstream part of such a supply chain plays the most significant role towards a sustainability objective [4], leading to increased organizational performance [5,6]. As a result, green sourcing and purchasing have a strategic role in the sustainability performance of a firm [7], and they have deservedly been in the focus of research and business practice [8,9], since they are also the activities that consume a great amount of a firm's capital resources [10]. Lately, the importance of the purchasing function and its environmental performance has further increased, as many firms concentrate on their core value-adding activities and choose to obtain the components and services needed from outsourcing partners [11]. Moreover, the purchasing function absorbs a great amount of the pressures exerted from a range of stakeholders, including national and international regulators, who, responding to the climate crisis, want to create and promote an overall greener business environment [12,13].

Green sourcing can be considered as the integration of environmental considerations in the acquisition of raw materials and components as well as capital goods, and is at the center of GSCM. It constitutes “the complex of mechanisms implemented at the corporate and plant level to assess or improve the environmental performance of a supplier base” [14]. In addition, environmentally friendly sourcing/purchasing practices lead to the direct involvement of the purchasing function/department in value creation activities, such as Life Cycle Assessment and environmental product/service design for recycling, reuse and resource reduction [15,16]. Overall, “green purchasing” is “nothing but purchasing with green concern” [2], and characterizes generic, or defines specialized, activities within the broader sourcing process. Besides the activities related to the acquisition of raw materials, it directly or indirectly affects suppliers operations, inbound distribution, production, packaging, recycling, etc., i.e., all activities until the final disposal of products. In this context, the environmental assessment and selection of suppliers are of great importance as they relate to both the sourced products/services and the wider context in which they are produced and/or delivered [7].

So far, supplier evaluation and selection in general, and according to environmental objectives in particular, have attracted the interest of many scholars [17,18]. However, this interest has been mostly expressed in the development of criteria and algorithms that facilitate the accomplishment of this task as a *decision-making problem* [8,17,19,20]. A great amount of research has been reported on setting industry-specific assessment criteria [19,21–23] and on developing mathematical methods and tools, such as multi-criteria optimization and other Operational Research (OR) methods, for green supplier evaluation [24,25]. In the same direction, research has been reported on the relation between green sourcing and performance [10,26], on attributes of suppliers that play a significant role in selection and partnerships [27,28], on human purchasing resources development for green sourcing [29], as well as on the rationale for, and contingencies of, selecting individual practices of green purchasing in specific sectors and geographic areas [3,13,30]. The former indicatively include industries/sectors such as automotive [21,31], food [22,32], footwear [33], as well as the public sector [13,34]. Area specific studies include, indicatively, China [26,32,35], Korea [30], India [36], Bangladesh [37], Germany [31], the USA [23,38], Portugal [19,39], Finland [4], Ghana [34], Australia [40], Romania [13] and Greece [41]. It should be noted that these are not industry comparative studies and many have a broader sourcing scope than that of green supplier evaluation and selection.

Although logically industry context and history should influence businesses activities, including sourcing in general and green sourcing in particular, some argue that the processes and the employment of supplier selection and assessment tools do not differ significantly, as practices across industries converge due to institutional pressures resulting in normative and mimetic isomorphism in seeking performance and legitimation [34,42]. So far, most of the green supplier selection (GSS) literature seems to adhere to this view and assumes, for all cases (industries), implicitly or explicitly, the same standard (rational) decision-making process [17]. Only the assessment/selection criteria seem to vary. Nevertheless, there are contrasting views insisting that industry context does matter and that green sourcing requirements are firm-specific and differ across industries in both content (*what* is sourced) and process (*how* it is sourced). The same tools of supplier assessment and selection may be used across industries, but they are employed in different ways and for different purposes, and, apparently, historical, contextual and practical reasons are responsible for these differences [38,43,44].

To address this open research question, in this paper, we investigate whether there are varying green supplier assessment and selection *organizational processes* across different industries shaped by their internal logics and context. Organizational processes are considered as more inclusive constructs than the purely cognitive decision-making process, incorporating activities such as visits to suppliers, “shopping” trips, collaboration acts with other functions, external organizations and authorities, use of artefacts, external and internal power conflicts, etc., which all have a role in assessment and selection. Some of these

have already been considered individually (e.g., [8,17]), but not in a holistic and consistent manner with a sound theoretical base, such that they can be thoroughly understood and employed in comparative contexts.

In line with the above argumentation, this paper adopts a systems perspective, and relying on social practice theory, considers sourcing as an *organizational process*, i.e., a set of activities/practices, of which supplier evaluation and selection is a sub-process. Green supplier evaluation and selection is, in turn, a directly related sub-process, carried out within the context of the latter. As sourcing, in general, moves from arm's length relationships to closer and more permanent partnerships of buyers with suppliers, it seems more appropriate to consider green supplier assessment and selection as two distinct but interconnected sets of practices/activities, which are carried out repeatedly (hence they become practices), even for the same supplier. This paper aims at exploring, recording and comparing environmental-management-related practices in both activities as they are carried out in different industries. We use a holistic and structured representation of the two sourcing activities and their context as 3rd generation activity systems (CHAT) to find and explain similarities and differences in green supplier evaluation and selection across these five industries in Greece.

Our practice perspective is motivated by the recently increased interest in the study of organizational phenomena as social practices [45,46]. Social practice theories maintain that there is a practical rationality rooted in the concrete detail of the daily life and the actions of individuals and organizations [47,48]. Practices are behavioral routines which encompass several interconnected elements: forms of bodily activities, forms of mental activities, artefacts and their use, know-how, emotions and background knowledge [49], which have been gradually institutionalized, in our case, in organizations and in their sourcing functions. Practice theories emphasize the role of interests in all aspects of human behavior, and hence they explicitly take into account power, conflict and politics in the analysis of social reality [46].

In the research methodology followed, initially, activity theory [50] was used for modelling the environmental assessment and selection practices as two envelope activity systems. The activity system construct allows the description of practices and their context in a structured and consistent manner. Relying on related literature, we then defined the elements of the two activities. Although the majority of such literature does not directly concern practices, it can provide leads to broader concepts that can be used to define practices/activities and their context. The definition of the elements of the two activities formed the basis for developing a structured instrument (questionnaire) to carry out empirical research on the practices of environmental assessment and selection of suppliers carried out in firms of five industries in Greece. After the preliminary development of the questionnaire, the five industries' basic related characteristics in the framework of the Greek economy were recorded and used to fine-tune the questionnaire. Then, the questionnaire was administered to the sourcing departments of companies belonging to the five chosen industries (construction materials, food, pharmaceuticals, fish farming and recycling and waste management). The responses were recorded, analyzed and compared using descriptive statistics and taking into account the industries' characteristics in the framework of the Greek economy.

The novelty and original research contribution of this paper is manifold and is outlined below.

- To the best of our knowledge, for the first time, it presents a comparative study of green supplier evaluation and selection practices across industries. So far, related studies have been either based on a single multi-industry sample, or they were industry specific. In addition, the majority of extant studies refer to general GSCM practices assuming supplier selection as an integral practice.
- It introduces an inclusive and consistent view of green supplier assessment and selection organizational process beyond that of a bare decision process. This perspective helps in understanding green supplier selection better, and enables a multidimen-

sional comparison of green supplier assessment and selection practices in different industries and organizational contexts.

- For the first time, it adopts a practice perspective grounded in a related social theory. The frequent lack of a theoretical base in green supplier selection research has been criticized since it degrades the validity of any empirical results [51]. Over the years, there is a tendency for employing theory in the general sourcing research, but the theories used are mostly economics-oriented [8].
- It presents the employment of an innovative hybrid qualitative–quantitative research methodology in which qualitative activity theory modeling is used in the development of a structured and consistent instrument for quantitative research on green supplier assessment and selection practices.

Following, in the paper, we first outline the basic elements of 3rd generation activity theory as a means of structural representation of sourcing practices. We then define the elements of the two aforementioned activities (supplier assessment and supplier selection), each comprising a bouquet of specific-objective-oriented practices. The elements of these activities are then used to develop the empirical research instrument (questionnaire). Before presenting the details of the questionnaire, we briefly review the organizational context of the firms of the five industries participating in our inquiry. This provides the context for the questionnaire items, as well as for the analysis of the results. The presentation of the empirical research procedure and the survey outcome obtained from a sample of 80 companies in Greece follow. After the analysis and discussion of the results, the conclusions of our research are drawn, exposing its limitations and providing suggestions for further work.

2. Sourcing as Activity System in Context

As a broad organizational process, sourcing can be thought of as comprising a number of distinct activities, i.e., selection of materials, parts and services on the basis of particular specifications; evaluation and selection of suppliers; adoption and consultation of standards for components, etc.; actual procurement; and quantity and quality control on delivery before storage and/or use. According to the strategies adopted and the emphasis given, some of these activities may be considered more important and attract additional interest, involving lengthy negotiations and deliberations among different stakeholders.

The consideration of the above in an organization-studies perspective addresses questions such as who actually does the assessment? What powers do she/they have? How do he/they interact with tools and artefacts for the assessment and selection? How are tools and artefacts related to the general supplier evaluation and selection? Which documents are being consulted, and what is their role in the definition of assessment and selection of precise objective(s)? What is the power and legitimation of managers and employees involved in the choice of methods/algorithms and criteria for evaluation and selection? In which legislative contexts are the assessment and selection being carried out? What is the role and power of the peripheral stakeholders involved in green sourcing? Do these organizational and broader contextual factors differ across industries and sectors? How are they related to other sourcing activities?

The above questions can be related to a number of macro- (envelop) and micro-activities, which when being carried out in a repeated form constitute practices. Hence, to answer the above questions, we employ 3rd generation activity theory (Cultural-Historical Activity Theory, CHAT) as a structured representational and analysis instrument for these practices and their context. Activity theory belongs to the corpus of practice theories, aiming to put in the “foreground the importance of activity, performance and work in the creation and perpetuation of all aspects of social life” [46]. In order to study how human activity develops from material actions and communication processes, Engeström developed the concept of *activity system* to include the context in which actions take place. In activity theory, the meaning of action and the context in which it takes place are not independent of each other [52].

The model of Engeström's that describes human activity and its context (at different levels) is depicted in Figure 1. The *subject(s)* is the person, or the group of persons (participants of the activity), organized or not, that is/are responsible for carrying out the activity. The *object(ive)* is the reason that the activity takes place. *Tools* (or *instruments*) are the means (technological artefacts or other more abstract means, such as language and signs) by which the activity is being carried out (or mediated) by the subject; *rules* are the cultural norms, rules and regulations governing and influencing the way the activity is being carried out; *community* denotes the environment, as far as stakeholders and their groupings are concerned, in which the activity is carried out, while the *division of labor* signifies who is responsible for what, how assigned roles are organized, and how power is distributed to the members of the community. The *outcome* of the activity is the desired outcome from carrying out the activity. It is important to note that in Engeström's activity model, the community and the rules are the carriers of the influences of the social context on the agents (subjects), whereas the tools and the division of labor denote the ways of thinking and acting imposed by hard and soft technology [53].

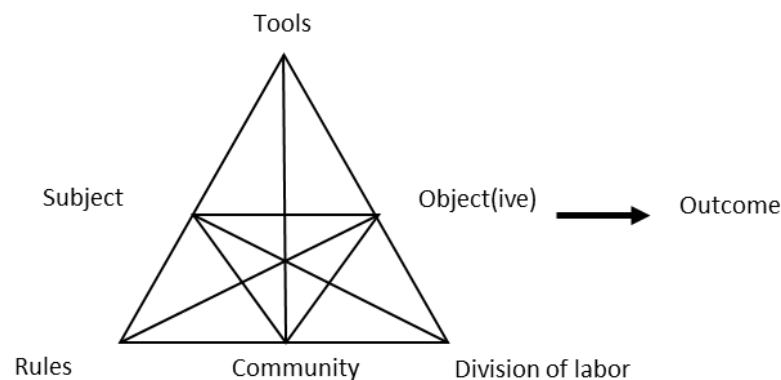


Figure 1. Engeström's model of the structure of human activity.

Engeström's activity model defines a *system*, meaning that each element performs a specific mediating function between its two adjacent elements. For example, the relation between "community" and "object" is mediated by the "division of labor" (who does what for transforming the problem space, i.e., the objective). A change in one of the three elements induces changes in the other two.

Activity systems are, in fact, by definition internally fragmented and inconsistent. They enclose a multitude of points of view, micro-activities/actions, histories and interests that result in tensions and conflicts in the construction of the object. Hence, they constitute the origin of the source of energy for the change and expansion of activity systems and their components [46]. The activities' internal "inconsistencies", or *contradictions*, are amplified by the interaction of different activities/activity systems (in fact, in the third generation of CHAT, Engeström proposes at least two activities as the minimal unit of activity-based analysis [50]). Contradictions may refer to inner conflicts in the elements of the nodes of the activity (primary contradictions), they may occur between nodes/elements of the activity system (secondary contradictions), they may also arise between an existing activity system and what is perceived as a culturally more advanced form of these same activity (tertiary contradictions), or they may occur between different co-existing activity systems (quaternary contradictions).

3. Activity Representation of Green Supplier Evaluation and Sourcing Practices

In the framework of activity theory, supplier evaluation/assessment and selection can be considered as two distinct, interconnected, corresponding activities (Figure 2). For buyer firms, this distinction facilitates the debiasing of the selection decision [54], whereas for researchers it allows them to identify tendencies of mimicking best practices [34]. The outcome of the evaluation activity is the means (tool/instrument) through which the

selection is carried out. Green supplier evaluation as a 3G activity is being carried out by the subject, which can be the Purchasing or Supply Chain Management Department of an organization [55]. The “Tools/instruments” node indicates how the assessment is carried out, by which means, and which material and/or ideational artefacts are used. For supplier evaluation, these may be formal documents and other tools [25,36,38], such as standards of requirements [56] and/or procedures and checklists for carrying out audits of suppliers [57,58]. The “Rules” element outlines the assessment institutional context, which may comprise formal and informal rules related to the process of assessment, including regularity and frequency of activity execution [3] and the intended use of the assessment, as long as it influences the way the assessment is being carried out. For instance, the intended use of assessment in improvement initiatives may focus on high-impact results-oriented areas [10,59]. Similarly, when cost is considered as important, financial data and tools play a significant role [10,60,61]. The way the environmental assessment is carried out is also influenced by its relative importance in the overall (not only environmental) assessment of suppliers [3,62]. The “Community” of stakeholders may include other agencies undertaking or assisting in the assessment [2,63]. Their relative importance/contribution to the objective of the activity is indicated in the “Division of labor” node [31]. Overall, the Purchasing Department may be the sole agency involved in the assessment activity [2], or it may be assisted by others providing more specialized expertise [3,63], or it may be accomplish the assessment in collaboration with suppliers, exchanging information [64]. Investing in collaboration with suppliers has been proven to augment the sustainability and the overall performance of firms [64].

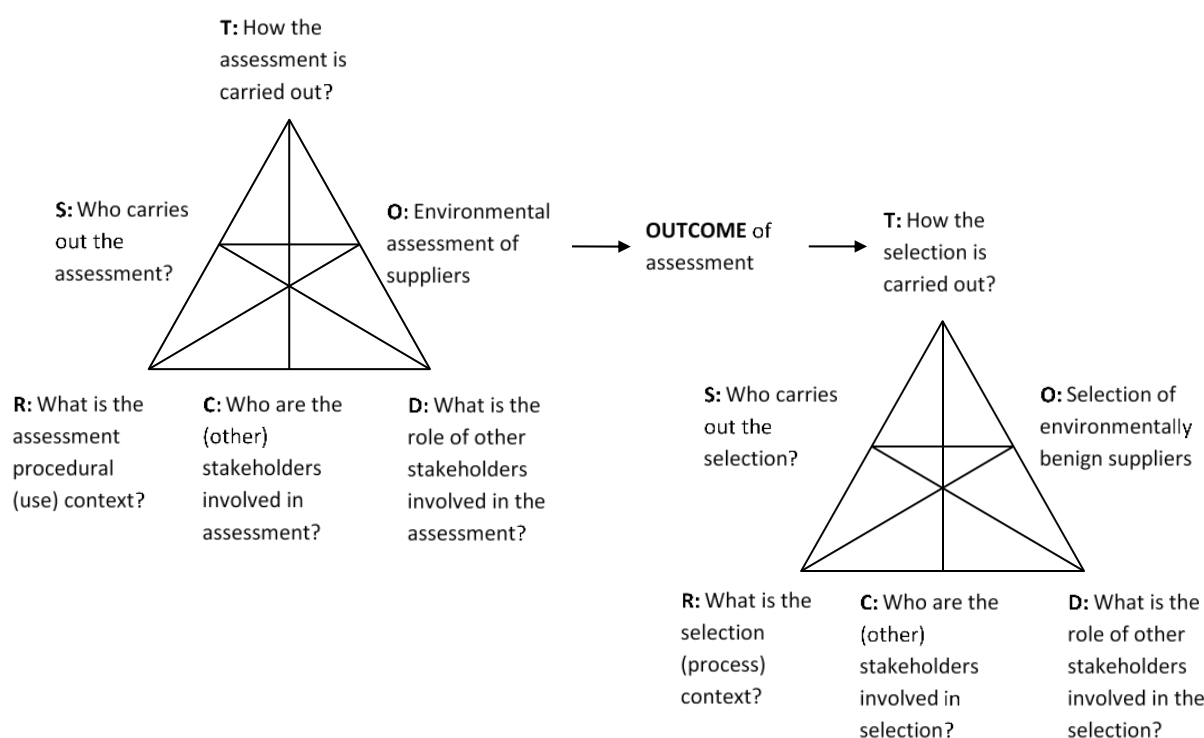


Figure 2. Environmental assessment and selection of suppliers as activities.

Regarding the companion “Selection” activity, again, in the majority of cases, the Purchasing/Sourcing department is the organizational unit that carries out the activity, though it is not the only one [65]. To accomplish this, it may use the outcome of the preceding and interconnected “Assessment” activity, which can be in the form of a “weighted” list of assessed suppliers. Additionally, or alternatively, the formal environmental credentials of suppliers may be taken into account [30,37,63,65]. The degree of trust in these may vary according to the dominant organization culture in the industry [2,66]. A number of actual or perceived past and/or potential behaviors of suppliers can influence the way the activity is

being carried out, e.g., the degree of importance of the assessment list or of the certification of suppliers. Frequently, supplier past behaviors influencing the selection activity include past greenwashing records [3,67], whether they maintain a dedicated environmental unit in the supplier's organogram [7,10], whether suppliers are engaged in industry-wide environmental initiatives [3], whether they exhibit an affinity for cooperation with customers in joint environmental initiatives [10,24,59,68,69], whether their products/services' ecological footprint has been noticeable [24,59], and whether they have an environmental culture and consciousness [12]. Regarding the "community" of stakeholders involved and the power they have in selection ("Division of labor"), in one way or another, certified suppliers or other related agencies are assigned an active role as *de jure* self-selectable (signifying increased power of suppliers and certifying agencies) [30,63]. On the other hand, when observations, deliberations and audits of suppliers are carried out with the direct involvement of the focal company and the related organizational units (*de facto* selection), the power to influence the objective is kept internally (result of mediation of "Division of labor") [23,30,63,69,70].

4. Green Sourcing in the Selected Industries

Companies from five industries that have particular importance to the Greek economy were chosen to participate in the research. Three of the industries/sectors (construction materials, waste management and recycling, fish farming) can be considered as principally dealing with *functional* products, while the rest (pharmaceuticals and food) are industries in which, in general, innovation and differentiation play a significant role in competition. In general, supply chains are configured according to this distinction [43], and relations among participants are conditioned by organization culture, which is influenced by the above characteristics of the industry that they belong to [71,72]. Hence, one may *a priori* argue that the practices of (green) supplier assessment and selection are influenced, directly and indirectly, by the industry context/characteristics as they are mirrored in the associated organization's culture [72,73]. Industry characteristics that play a determining role include the regulating environment and the intensity of regulation, the role of technology and innovation in the dynamics of the industry, the growth dynamics of the industry, the importance of, and respect for, people and team orientation, and the degree of customer orientation, including ethical and social responsibility issues [72,74]. Regarding the pair of technology and industry dynamics, it has been observed that assembly-line-like configurations and low growth characterize industries whose companies pay particular importance to stability, performance and detail, whilst industries with customized, innovative technologies and high growth pay particular importance to people and team orientation [75,76]. Industries with mediating technologies that sort inputs/suppliers and customers into groups can be placed somewhere in the middle between seeking both stability and innovation in their organizational culture [72]. More recently, a different categorization scheme has emerged from a complex systems perspective. In this, the depth and complexity of an industry's supply network (the number and variety of *trophic levels*, i.e., number of inputs/tiers in supply), influences the innovation potential and the dynamism of an industry [77].

All these internal and external environmental characteristics can be captured in the structure and the elements of green sourcing activities. Trophic level influences the complexity of the tasks of supplier assessment and selection and the visibility of higher tier suppliers. The degree of regulation of an industry is usually linked to a tendency to use standards and formal reporting. High trophic levels are associated with an innovation culture, while industries with low trophic levels focus on efficiency and performance as means of gaining competitive advantage [44]. Innovative firms are more open and may involve, directly or indirectly, various external stakeholders in their sourcing activities. In addition, industries whose operations are in direct contact with the natural environment, and whose environmental footprint is obvious, tend to emphasize Corporate Social Responsibility (CSR) initiatives throughout their supply chain [7,78] and select suppliers along these lines. Industries with high trophic levels seem to rely on standards, because it is quite

complicated to carry out audits, etc., throughout the supply network. The opposite is true for low-complexity customer-oriented industries [7].

Coming to the specific sample industries, the *construction materials* industry in Greece encompasses a number of firms with diverse activities, ranging from operation of quarries to the production of high-technology synthetic insulation blocks and self-sensing, self-healing and self-cleaning smart materials (the latter are absent in our sample). It can be considered as a functional products industry in which innovation is slow. It has no endogenous growth dynamics, and demand and growth are highly dependent on the general economic climate. In Greece, the use of materials in infrastructure construction has slowed down in the past two decades after the boom of the late 1990s and early 2000s, which includes the 2004 Olympic Games. However, the housing construction sector has always been particularly strong due to the high percentage of home ownership and a habit to channel micro-investments in housing. Lately, there is a trend towards residential constructions to support the flourishing tourism industry [79]. The majority of the construction material firms are small, as far as human resources are concerned, and are characterized by a rigid efficiency-seeking culture. They are engaged in various environmental-footprint-producing activities along the value chain, i.e., extraction, storage, processing and transportation of materials.

In construction, many consecutive operations of the value chain take place in (the same) construction sites, so the boundary between suppliers and producers can be fuzzy. This implies that in the construction materials sector/industry, forward or backward integration may shift the environmental burden accordingly. It is a customer-oriented industry in which the target customer construction industry is a highly complex industry with a variety of contractors and subcontractors whose environmental performance is difficult to regulate. Although lately there has been a trend for environmentally friendly materials, the effects of the operations of the industry remain questionable, as far as environmental performance is concerned. There is a tendency and imperative to use recycled raw materials, or materials which are byproducts, or co-products, of industrial processes, thus upgrading the role of suppliers and reverse logistics [80]. Currently, more than 50% of new houses can be broadly considered as environmentally friendly constructions. However, still 20% of global pollution comes from the construction sector [81]. Overall, the environmental performance of the industry depends more on the extraction and transportation methods of suppliers and/or producers rather than on the processing ones. It is a medium-visibility industry with respect to the supply side, i.e., the construction material producers have a partial view of the operations of their suppliers [82].

Related to the construction materials industry is the *waste management and recycling* industry. This is also a functional products/services industry with medium visibility, as the exact origin and content of waste cannot be easily identified. In Greece, it is a relatively new industry, at least in its current form, and is not sufficiently regulated by standards and directives, exhibiting a relatively high growth (ninety-four private firms are members of the industry's collective representation institution, the so-called Greek Association of Environmental Protection Firms). It is a low trophic level and low technology customer-oriented industry whose participant firms seek stability. Ethical and CSR issues play an important role. The environmental performance of suppliers is contingent on how waste is produced, collected, stored and transported before the companies of the sector get involved. Again, this is an industry where no real barriers to forward and backward integration exist, and a sharp distinction between supply and value-adding processes is not easy. Suppliers of the industry can be municipalities, industrial firms, households, construction companies, etc. The industry's suppliers are also the suppliers of collection, storage, transportation and processing systems, such as bins, specialized sorting machinery, etc. The collaboration of suppliers and collectors/processors is important for many activities, such as sorting.

Fish farming (aquaculture) is the "fastest growing food production system in the world" [83] and an important economic activity in the Mediterranean. It, however, constitutes an intervention in the natural environment, and hence there is an effort to mitigate

its effects all along its supply chain. There are more than 1000 aquaculture sites in Greece, 85% of which are in sea water, many in remote poor islands with their local value chains. Over the last years, due to numerous financial problems, the sector has consolidated in a small number of large firms [84]. It is a low-trophic level and low-innovation industry, in which reliability in supply (quantity and quality) is of great importance. Its pool of suppliers includes suppliers of fingerling, as well as suppliers of fish food, antibiotics and related substances, machinery, such as pumps, as well as other equipment and devices, such as (recyclable) nets and breeding tanks. The industry and its suppliers are regulated for product safety and environmental performance, as, in one way or other, their operations are interventions in the natural environment. Ethics and CSR are issues of concern for the industry.

The *pharmaceuticals industry* is one of the most important global industries, with high growth potential (pharma sales are expected to reach USD 3 trillion by 2030), and has become even more important after the COVID-19 pandemic. Over the years, the industry has become very complex and operationally dispersed, with inter-regional trade amounting to 60% of the total trade. The pharmaceutical companies in Greece are mostly producers of generics or licensees to Big Pharma. They have limited R&D activities [85]. As it directly relates to human health and wellbeing, it is a strongly regulated industry. In addition, it is a high-trophic level industry, in which suppliers are active in the production of chemical and biological substances, (recyclable) packaging materials (plastic, glass, aluminum, paper, etc.), drug administration materials and devices (e.g., syringes), and specialized production machinery (reactors, containers, etc.). In general, the industry is one of the most innovation-driven industries, with low visibility, as far as supplier activities are concerned. In companies with R&D activity, there is increased interest in human/intellectual resources. Initiatives to include sustainability in the associated regulatory framework are underway at both national and trans-national levels, supporting the use of recyclable and non-polluting materials and substances in more environmentally friendly operations.

Finally, the *food industry* is also a regulated industry, as far as its products are concerned, in which emphasis is put in the traceability of the ingredients and substances used [86]. The food industry is one of the strongest industries in Greece, accounting for 10% of the employment and 28% of the economy's manufacturing activity. Small local specialized firms co-exist with large multinational conglomerates. The industry comprises a very wide base of producers and suppliers, extending from producers of fresh fruits and vegetables to producers of processed meat products and frozen ready meals (over the last years, a considerable increase in spending in packaged food has been recorded). There are 76 food products with PDO (Protected Designation of Origin) and 30 with PGI (Protected Geographical Indication) in the Greek territory [87]. The industry is a high-trophic level one, but in the case of Greece, it is lower compared to more advanced economies with more advanced food technology. Sourcing is geographically diverse, extending from local suppliers to suppliers situated in different continents. In the latter case, supplier assessment has to rely on accreditation and certification, as auditing is expensive and time consuming [32]. Over the last decades, the industry has been transformed into an innovation-based one in order to offer products that are compatible with the complex life patterns of the developed and developing world. Suppliers are primary stakeholders in sustainability assessments, with exact roles depending on the integration of their operations with those of the buyer company. Frequently, the environmental assessment of remote suppliers is associated with safety and ethical issues, such as work conditions, child labor, etc. [86]. Apart from suppliers of raw or pre-processed ingredients, of particular importance is the environmental assessment of packaging systems suppliers [22]. This assessment needs to be performed to the extent of a life-cycle, for the products per se, but also for the terms of use they impose on the buyer firm.

Based on the above brief industry descriptions in the context of the Greek economy, the specific research question becomes how industry characteristics and organizational

culture, as briefly depicted above, influence green supplier assessment and selection activities/practices, modeled as CHAT activities.

5. Empirical Research Procedure

To carry out the research, a questionnaire was developed based on the aforementioned activity-based representation and analysis. The items of the questionnaire corresponded to the elements of the assessment and selection activities. This is a methodological practice that allows the construction of instruments of empirical research in a structured and holistic manner [88]. It also facilitates the analysis of the results.

The questionnaire was administered electronically in May 2022 to sourcing managers in a number of companies, constituting a convenience sample of size eighty (80). Although the guiding principle of such a method (*convenience sampling*) is to form a sample based on convenience and the availability of participants [89], in our case, the choice of sectors and their representation was based on their importance to the local economy (Greece) and their overall relative contribution to sustainability. In addition, the companies and the sector representation were chosen to be as close as possible to the industry statistics in Greece. These sectors are important for the Greek economy in terms of both their contribution to the economy and for the wellbeing of the population.

The sector distribution of participant companies is given in Table 1, while employment statistics are depicted in Table 2.

Table 1. Sectoral distribution in the sample.

Sector/Industry	Number in Sample (n)	Percentage (%)
Pharmaceuticals (P)	14	17.5
Construction materials (C)	10	12.5
Food processing (F)	23	28.7
Fish farming/Aquaculture (A)	20	25.0
Waste management and recycling (W)	13	16.3
Total	80	100

Table 2. Employment demographics of the companies in the sample.

No. of Employees	Number in Sample (N)	Percentage (%)
0–20	41	51.2
20–100	14	17.5
100–200	10	12.5
200–500	8	10.0
>500	7	8.8
Total	80	100

The questionnaire was developed in Google Forms, and the associated link was sent to the prospective respondents by e-mail.

Questionnaire

The items/questions in the questionnaire were organized according to the structure and the logic of the supplier evaluation and selection activities, as depicted above in Section 3. Certain items were similar for the two activities, differentiated only by the objective of the activity (assessment/selection). The questionnaire items are listed with the corresponding explanations in Tables 3 and 4.

Table 3. Questionnaire items for the activity “Assessment”.

Construct	Question	Explanation
Objective	ASSESSMENT	Environmental assessment of suppliers
Agency/subject of assessment	Supplier environmental assessment is carried out by the purchasing department (A1)	Who carries out the assessment
Tools/instruments of assessment		How the assessment is carried out
Audits	Supplier green audits are seriously taken into account and used for their assessment (A2)	Through audits
Legislation	We are contented with the national legislation of assessing the environmental performance of suppliers (A3)	Using national legislation guidelines
Rules/habits influencing the assessment activity		What is the assessment procedural (use) context
Regularity of assessment	Environmental assessment of suppliers is carried out regularly (A4)	Frequency of assessment
Context of assessment	Environmental assessment of suppliers is used in improvement initiatives (A5)	(Potential) use of assessment in improvement initiatives regulates/influences the way the activity is carried out
	Environmental assessment of suppliers is taken into account in managing costs of supply chain (A6)	(Potential) use of assessment in supply chain cost management regulates/influences the way the activity is carried out
	Environmental assessment of suppliers is taken into account in the overall assessment of suppliers (A7)	(Potential) use of assessment in the overall assessment of suppliers regulates/influences the way the activity is carried out
Community of assessment activity		Who are the (other) stakeholders involved in assessment
	Specialized agencies contribute to environmental assessment of suppliers (A8)	Other parties contributing to the assessment practices
Division of labour in assessment		What is the role of other stakeholders involved in the assessment
	(Only) purchasing departments are involved in environmental assessment of suppliers (A9)	None
	Specialized agencies contribute to environmental assessment of suppliers (A10)	Provide specialized knowledge

Table 4. Questionnaire items for the activity “Selection”.

Construct	Question	Explanation
Objective	SELECTION	Selection of environmental benign suppliers
Agency/subject of selection	Selection of (green) suppliers is carried out by the purchasing department (S1)	Who carries out the selection
Tools/instruments of selection		How the selection is carried out

Table 4. Cont.

Construct	Question	Explanation
Role/importance of assessment	Selection of suppliers is based on environmental assessment (S2)	Using the results of environmental assessment
Sufficiency of national inspection/accreditation framework	Suppliers environmental certification is important in supplier selection (S3)	(Also) taking into account the environmental certification of supplier(s)
	The existing legislation framework for accountability in green supplier selection is sufficient (S4)	Trusting the relevant legislation framework
Rules/habits influencing the selection activity		What is the selection (process) context
Commitment to environmental performance	Supplier selection takes into account greenwashing behaviours (S5)	Formal and informal supplier behaviors influencing/governing the execution of the selection activity
	Supplier selection takes into account the existence of a dedicated environmental unit in supplier's organogram (S6)	>>
	Supplier selection takes into account the transparency of its environmental assessment/management processes (S7)	>>
	Participation of suppliers in industry-specific environmental initiatives is sought for (S8)	>>
	Co-operation with customers in environmental improvement initiatives is sought for (S9)	>>
	The ecological footprint of suppliers' products/services is important for their selection (S10)	>>
	Suppliers' environmental culture and consciousness plays an important role in suppliers selection (S11)	>>
Community of selection activity		Who are the other stakeholders involved in selection
	Certified suppliers with respect to green practices are selected de juris (S12)	Agencies indirectly providing accreditation and certification. Environmentally benign suppliers are selected by the focal company unless they are holders of appropriate certificates which make them qualify automatically
Division of labour in selection		What is the role of other stakeholders involved in the selection
	Certified suppliers with respect to green practices are selected de facto (S13)	Auditing by the purchasing department is more important.

6. Results

The Cronbach's alpha index was used for assessing the reliability of the research instrument used. Its value was calculated to $\alpha = 0.884$, which is an acceptable value. The values of the Kolmogorov–Smirnov index indicated that the responses did not follow a normal distribution (p -value < 0.05). Descriptive statistics of the results are depicted in Tables 5 and 6. As indicated at the bottom of Table 6, ranges of values are distinguished by different colors.

Table 5. Degree of Agreement/Consensus in activity “Assessment”. [MoM: mean of the means of the five sectors].

Activity Element/Item	Agreement (Mean)							Consensus (CV)						
	all	W	F	C	A	P	Range	all	W	F	C	A	P	MoM
Subject														
A1	2.91	2.92	2.80	2.65	3.10	3.36	0.48	0.39	0.38	0.30	0.45	0.42	0.40	0.15
Tools														
A2	3.90	4.15	3.85	3.87	3.60	4.00	0.55	0.23	0.26	0.19	0.21	0.33	0.24	0.21
A3	2.96	3.00	3.30	2.83	2.70	2.86	0.60	0.25	0.41	0.17	0.20	0.30	0.27	0.34
Rules														
A4	3.95	3.92	3.95	3.91	3.80	4.14	0.34	0.18	0.16	0.13	0.17	0.27	0.21	0.29
A5	3.84	4.00	3.90	3.61	4.10	3.79	0.49	0.24	0.18	0.23	0.26	0.24	0.26	0.14
A6	3.27	3.38	3.55	2.96	2.90	3.57	0.67	0.28	0.23	0.26	0.33	0.34	0.26	0.18
A7	4.26	4.08	4.45	4.13	4.00	4.57	0.57	0.18	0.23	0.20	0.18	0.29	0.14	0.26
Community														
A8	4.08	3.77	4.25	4.04	4.20	4.07	0.48	0.18	0.29	0.10	0.17	0.19	0.20	0.35
Division														
A9	4.08	3.77	4.25	4.04	4.20	4.07	0.48	0.18	0.29	0.10	0.17	0.19	0.20	0.35
A10	2.91	2.92	2.80	2.65	3.10	3.36	0.71	0.39	0.38	0.30	0.45	0.42	0.40	0.15

Table 6. Degree of Agreement/Consensus in activity “Selection”.

Activity Element/Item	Agreement (Mean)							Consensus (CV)						
	All	W	F	C	A	P	Range	all	W	F	C	A	P	MoM
Subject														
S1	2.91	2.92	2.80	2.65	3.10	3.36	0.71	0.39	0.38	0.30	0.45	0.42	0.40	0.15
Tools														
S2	3.80	4.08	3.70	3.39	4.20	4.07	0.81	0.19	0.12	0.20	0.26	0.15	0.15	0.31
S3	3.41	3.31	3.35	3.48	3.00	3.79	0.79	0.25	0.23	0.24	0.27	0.22	0.28	0.10
S4	2.96	3.00	3.30	2.83	2.70	2.86	0.65	0.25	0.41	0.17	0.20	0.30	0.27	0.34
Rules														
S5	3.75	3.92	3.65	3.74	3.80	3.71	0.27	0.25	0.26	0.22	0.26	0.27	0.25	0.08
S6	3.57	3.69	3.50	3.22	3.80	4.00	0.78	0.23	0.20	0.24	0.30	0.17	0.20	0.22
S7	3.83	3.92	3.65	3.78	3.50	4.36	0.86	0.22	0.16	0.24	0.22	0.34	0.17	0.31
S8	4.04	4.23	3.70	4.00	4.30	4.21		0.20	0.10	0.20	0.28	0.19	0.19	0.33
S9	3.50	3.92	3.65	3.09	3.30	3.71	0.83	0.32	0.28	0.24	0.42	0.32	0.34	0.21
S10	3.66	3.92	3.55	3.52	3.60	3.86	0.40	0.25	0.22	0.23	0.28	0.19	0.28	0.16
S11	4.18	4.15	4.00	4.00	4.80	4.29	0.80	0.18	0.17	0.21	0.21	0.09	0.17	0.30
Community														
S12	3.92	4.23	3.85	3.65	3.80	4.29	0.64	0.22	0.20	0.26	0.28	0.21	0.11	0.32
Division														
S13	4.10	4.31	4.15	3.91	4.30	4.00	0.40	0.18	0.15	0.18	0.20	0.16	0.22	0.17

: strong agreement (>4) in overall sample (all);
 : weak agreement (<4) in overall sample (all);
 : higher dispersion (CV > 0.3) in MoM;
 : lower dispersion (CV < 0.1) in MoM;
 : high (>0.80) or low (<0.35) range.

7. Discussion of the Results of the Survey

Tables 5 and 6 present the results of the exploratory survey along two dimensions: degree of agreement (after comparison of average values of responses in the Likert 1 to 5 scale), and degree of consensus, i.e., extent to which responses cluster around average values, measured by the Coefficient of Variation (CV).

Looking at these results for each activity element, it becomes apparent that, as far as the formal and informal rules/habits that influence the assessment activity are concerned, the pharmaceuticals industry seems to be more accustomed to regular supplier assessment for sustainability as a practice imposed by national and international industry standards and good laboratory and manufacturing practices. At the opposite end (no regular assessment) is the aquaculture industry, which has a limited supplier base in both breadth and depth, and whose principal suppliers are either certified nutrition and medicines suppliers or suppliers of capital goods. The latter are not sourced regularly, and when so, they are purchased from the same suppliers. Buyer-accomplished supplier audits are popular in the relatively young waste management industry, where widely acceptable standards do not exist (yet). At the other end of the spectrum, as regards the means of environmental assessment, buyer-initiated audits are not common practice in the highly regulated pharmaceuticals industry, where national and international accreditations and certifications by third-party accreditors are the norm.

In all five industries, the subject of the assessment activity (the carrier of practices) is the purchasing/sourcing organizational unit, although low agreement and consensus values indicate that it is not the only one. Due to its low trophic level (internal and external complexity) and relatively low technological dependence, the construction materials industry seems to be the least dependent on a specialized/organized purchasing unit. The involvement of other (external) stakeholders in the assessment activity (as indicated in items related to the “community” element) is more obvious in the food and aquaculture industries, where traditionally the role of public health and safety agencies is very important, and customers are actively involved.

Contextual factors influencing the supplier environmental assessment activity, such as the intended use of the assessment in operational improvement, seem to be more important in the waste management and aquaculture industries (in these industries results of assessment are listed in CSR reports). One reason is that their operations are embedded in the natural environment, and the use of products and services sourced is directly related to these operations. In addition, regarding waste management and recycling, it is a customer-oriented industry, and operational improvement implies better integration of the companies’ processes with nature’s processes. As far as the contribution of the environmental component in the overall assessment of suppliers is concerned, including the assessment of its contribution in cost reduction [90], in general, there is agreement and consensus in responses. Agreement is stronger in the food and pharmaceutical industries that have complex multi-level supply chains with many points of interaction with the natural environment.

Overall, supplier environmental assessment practices seem to converge in the dimension of agency (who carries out the assessment), in the involvement of various third parties in the assessment for providing technical (in complex industries with high trophic levels) and procedural knowledge/expertise (in young industries with low trophic levels), and in the role of environmental assessment in the overall assessment of suppliers (justified by the increased importance of ESG initiatives). There are discrepancies in the other aspects of the activity context stemming from internal and external organizational idiosyncrasies (maturity, science-orientation, etc.). For instance, in the construction materials and fish farming industries, due to their inelastic cost structures, the objective of cost reduction does not seem to influence significantly the overall objective of the assessment activity.

Regarding supplier selection, again, in all industries in the survey, the main subject of the activity is the Purchasing/Sourcing organizational unit. With the exception of the construction materials and the food industries, companies in all industries use the results

of the preceding environmental assessment activity for the selection of suppliers (high consensus). In the case of construction materials, supplier assessment is difficult to accomplish with rigor, whereas in food processing companies, the overall legislative framework indirectly imposes assessments based on accreditations and certificates issued by third parties. In the low-trophic level waste management and fish farming industries, whose operations are embedded in the natural environment and directly affect local communities, public authorities play an important role in the assessment and indirectly in the selection of suppliers. The responders indicated that the sufficiency of the legislation framework is questionable. In all the participating industries, greenwashing records of a supplier seem to automatically terminate its selection activity. In the pharmaceuticals industry, the existence of a specialized environmental unit in the supplier organization facilitates the selection practices, as a rich communication link between similar organizational units among buyers and suppliers can be established [7,55]. In all cases, with the exception of aquaculture, which has a low trophic level, transparency of environmental management processes is considered important for carrying out selection, especially in the complex pharmaceuticals industry. Other contextual factors that influence selection practices are the participation of suppliers in industry-specific initiatives (with the exception of the food industry, probably due to the complexity and diversity of its supply network), cooperation with customers for improvement (implying indirect legitimation by the customers) [69], the general environmental image and (visible) culture traits of suppliers (strong agreement and consensus in responses).

Finally, regarding the division of labor, *de juris* selection (i.e., active role of standards and legislation) is more popular, as expected, in the pharmaceuticals industry, whereas it is considered not important in the waste management sector, although in the latter case the selection becomes easier and more legitimate if a formal system is available.

Overall, there is convergence of the participating industries in the selection activity (practices) in the subject of the activity, the influence of greenwashing records of suppliers in the execution of the activity, the importance of the availability of audit-based information and the existence of an environmental culture in suppliers' operations.

In a more qualitative perspective, relying on activity theory, one can identify points where contradictions arise, or may arise, and reduce the performance of activities. For instance, beyond the primary contradiction between cost reduction and activity(-es) performance (traditional contradiction between use value and exchange value [52] in the objectives of the two activities), apparently, a secondary contradiction is emerging between the formally assumed assessment carried out by the sourcing department and the actual gradual reliance on external agencies as a consequence of industry habits and trends. The co-existence of buyer-accomplished supplier audits with assessments performed by external agencies may also be a point of contradiction. A more important tertiary contradiction may arise between the assessment and selection activities when an assessment is carried out by a purchasing unit's audits, but management uses supplier accreditations and/or certifications for selection and alignment with the industry's dominant trends.

Overall, general patterns of practices in green supplier assessment and selection recorded include:

- Systematic regular assessment based on standards is common in mature industries of large companies with high trophic levels (large and complex supply networks).
- Buyer audits are common in young highly transparent industries, such as waste management and recycling.
- Firm size, maturity and complexity of supply network influence the role of the purchasing unit in environmental supplier assessment and selection.
- In general, the buyer's purchasing organizational unit is not the only agency involved in the supplier assessment and selection process (it has no unlimited power in related decisions).
- When industries involve public health and safety authorities, in general, the role of third parties/agencies in supplier assessment is augmented.

- In low-trophic level industries, such as aquaculture and waste management and recycling, the suppliers' environmental assessment is associated with potential triggering of process improvements based on the results of assessment.
- The environmental dimension is considered important for the overall assessment of suppliers more in high-trophic level industries, such as food and pharmaceuticals.
- In all participating industries, the results of the environmental assessment are used for supplier selection. This trend is weaker in the food and construction materials industries.
- Public authorities and industry standards play an important role in supplier selection in the low-trophic level waste management and aquaculture industries.
- In all industries, discovery of greenwashing practices can halt the selection process for a specific supplier.
- In the science-based pharmaceuticals industry, the existence of a specialized environmental management unit in suppliers facilitates the selection activity (it becomes more collaborative). The same is true regarding the transparency of the environmental management processes of suppliers.
- The participation of suppliers in industry-specific initiatives facilitates the selection activity due to information sharing during the initiative.
- Apart from providing a sense of indirect legitimation, the cooperation of suppliers with end customers facilitates the selection process due to the exchange and diffusion of information and the sharing of risks.
- De jure supplier selection, which implies limited involvement of buyers in assessment and selection, is more popular in standards-based industries, such as the pharmaceuticals industry.

8. Conclusions

Why is it important to explore why and how environmental assessment and selection is actually being carried out in different industries? First, it is because we need to understand the contexts in which methods and tools of green supplier assessment and selection are employed, so that we can assess their suitability to specific organizational situations. It is also important because the position and power of different agencies and artefacts involved and employed, respectively, play an important role in the outcome of the assessment, and consequently, on the overall environmental performance of the industry's supply chain. This is of interest for the governance of individual firms, as well as for policy makers at the national and trans-national levels. Companies' top management may pay attention, assign responsibilities and direct resources to specific organizational units according to their role in the evaluation and selection tasks. Similarly, governments may exert pressure on the development of industry and cross-industry standards and monitoring, auditing and certification procedures. Furthermore, stakeholders need to understand the cultural and historical conditions in which the (collaborative or not) practices of environmental assessment and selection of suppliers have been institutionalized.

Having these in mind, in this paper, we have tried to record supplier environmental assessment and selection practices in five industries in Greece in order to understand their development and the similarities and differences across them. A social practice perspective based on Cultural-Historic Activity Theory was employed for carrying out the endeavor in a structured manner. The green assessment and selection activities with their attributes were mirrored in a structured questionnaire distributed to companies of the five participating industries.

The responses revealed that, concerning the assessment activity (set of practices), there is convergence in the involvement of external agencies for providing technical and procedural expertise and in the importance given to the environmental assessment as part of the overall supplier assessment. Industry-specific internal and external organizational factors limit convergence in the other aspects of the supplier assessment activity. As far as supplier selection is concerned, the identification of an environmental culture in suppliers and the availability of audit-based positive assessment seem to influence positively the

selection in all industries, whereas in all cases greenwashing acts an insurmountable obstacle for a supplier to be selected. In general, green supplier assessment practices seem to be influenced by industry characteristics more than selection ones, in which there is agreement in pivotal practices.

In general, for the first time, this paper revealed and discussed indications/patterns of, and differences in, attributes of adopted and institutionalized practices for the environmental assessment and selection of suppliers in specific industries (food, pharmaceuticals, aquaculture, construction materials, waste management and recycling), in a specific geographic and economic context (Greece). Clearly, this is an explorative study in a specific context, and observations and explanations, which are based on a limited sample size, can be generalized with caution only for similar contexts. However, in addition to the novelty in the scope of the research, the methodology followed and the indicative patterns observed pave the way for the introduction of a novel organizational-studies perspective on green supplier assessment and selection and green sourcing in general. In this manner, this research endeavor served its purpose, and the intended contribution to the relevant scientific community cannot be ignored.

To sustain and augment the importance of this research stream, further research is needed in both depth and breadth. Regarding the former, in-depth qualitative case-based research can provide more insights on the reasons and specific organizational culture traits that lead to the adoption of specific assessment and selection practices. In the same direction, the explorative study presented in this paper can be complemented with the development of hypotheses about the adoption of specific practices in specific industry contexts and their consequent testing in larger samples using inferential statistics. Measures of the degree of agreement/disagreement can be determined. As far as breadth is concerned, the research can be extended to a multi-national multi-industry study for identifying converging and diverging trends across industries in different countries. Clearly, these will result in more insightful conclusions about institutional isomorphism in green supplier selection practices.

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