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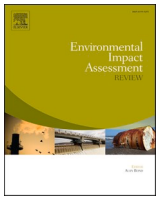

Impact of eco-labelling on the implementation of sustainable production and consumption

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1. Introduction

The high economic growth observed in recent years has triggered a global increase in consumption, which in turn has had a damaging effect on the natural environment. Should the economy continue to expand at its current rate and if irresponsible consumption and production patterns are maintained, the natural environment is expected to deteriorate further (Taufique et al., 2014). Due to the increasingly adverse impact of mass manufacturing and consumption, developing foreground knowledge on product quality with a view to reducing the volume of resources used throughout the product life cycle has become an issue of paramount importance (Chinese et al., 2001; Van Der Werf and Salou, 2015).

The key challenge is to develop a system that educates consumers on the impact of products upon the natural environment throughout their entire life cycle, but which at the same time can also provide producers with the opportunity to inform consumers about the advantages of their products. One such solution is eco-labelling, which is considered one of the key consumer educational tools for environmentally-friendly products (Buelow and Lewis, 2010; Bertrandias et al., 2017; Di Martino et al., 2019).

Until now eco-labelling has been identified as a one-way communication tool notifying consumers of a product's ecological impact. The benefits for an enterprise have not been analyzed. However, the growing popularity of eco-labelling over the years must be seen in the context of the advantages that it may bring to both enterprises and consumers (Wang et al., 2015). In recent decades eco-labels have become a strategic means of communication for environment-friendly products (Bougherara and Combris, 2009; Clemenz, 2010; Song et al., 2019). Their positive impact as a means of drawing consumers' attention to the identity of organic products has been noticed by companies and organizations (Joshi and Rahman, 2015; Sammer and Wüstenhagen, 2006). From a company's point of view, eco-labels are expected to promote organic products and give them a competitive advantage. In the case of the consumer, eco-labelling is designed to reduce any uncertainty they may have regarding the environmental impact of products as well as to help consumers choose those products that cause less ecological damage throughout their whole life cycle (Murali et al., 2018). Therefore, in the present article eco-labelling is assumed to play an important role in accomplishing both sustainable production and sustainable consumption. An eco-label is a "new" kind of environmental policy instrument that stresses the role played by information in communicating a product's impact upon the environment in terms of its production, distribution, consumption and/or disposal (recycling), namely the entire product life cycle (Fan et al., 2019). While eco-labelling has been much discussed in the literature, in our own work we have focused on the task of filling an important research gap, namely providing an assessment of this tool's significance in the implementation of sustainable production and sustainable consumption. For many years eco-labelling in its myriad

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forms has tended to be applied as a marketing tool for organic products (Bullock and Van Der Ven, 2018).

Organic products are comprised of safe components and non-toxic ingredients that may be reused and have no adverse impact upon the environment throughout their life cycle (Mufidah et al., 2018).

Given the above assumptions, the principal objective of this article is to assess the contribution of eco-labelling to promoting sustainable production and consumption. Achieving this goal in turn required focusing on the following immediate tasks:

- assessing the significance of ecological prerequisites in product-related decisions made by companies,
- determining consumer purchasing decisions.

To evaluate the impact of eco-labelling upon the implementation of sustainable production and consumption, we used the Analytical Hierarchical Process (AHP) method. An analysis of a decision-making problem consists of two stages, i.e. firstly, the development of a hierarchical structure of an item, and secondly an assessment of groups of items. For the purposes of this analysis, three models were prepared: (1) a model showing the impact of eco-labelling upon sustainable production and (2) a model describing the impact of relevant factors upon consumer purchasing decisions, and (3) a model (combining first two) evaluating the need for mandatory eco-labelling on products.

2. Literature review

2.1. Eco-labelling

Eco-labelling is a system that informs a consumer of the environmental impact of products throughout their life cycle. Eco-labels are characteristic of a pre-set graphic form and constitute proof of compliance with specific norms on the part of a producer. As a consequence, organic products cannot be labelled arbitrarily or randomly at the producer's discretion. Eco-labels are not obligatory, but they may be used only if they comply with the norms in force for a specific label (Network et al., 2004; Schumacher, 2010). Thus an eco-label is a distinctive form of labelling that communicates to the consumer that a given product has a mitigating environmental impact compared to other products with kindred features. Product usability comparisons are stressed, drawing attention to ecological quality as the category on the basis of which eco-labels should be assigned and evaluated. Some eco-labels may have a broader applicability. For instance, they may take into account social issues other than ecological ones (Gutierrez et al., 2020; Les Carlson and N. K., 1993; Loureiro et al., 2002).

Eco-labels thus constitute an important tool for increasing consumer confidence in products and services that are friendly to the environment. Consumer attitudes toward eco-labelling matter because consumers should know the meaning of respective eco-labels and trust them, too (Bougherara and Combris, 2009; Gallastegui, 2002). On the other hand, it is worth noting that both irregularities in monitoring and an imperfect regulatory system have given rise to possible improper uses of eco-labelling on the market, thereby undermining the credibility of this tool (Lyon and Montgomery, 2015). According to Gallastegui, eco-labelling has two primary aims. The first is to make consumers aware of the effect of their consumption on the environment and to encourage consumers to change their attitudes and adopt sustainable consumption models. The second aim is to motivate governments, producers, and other suppliers to render services and manufacture goods that conform to environmental standards (Gallastegui, 2002). Therefore, it is plausible to argue that the goal of eco-labelling is to generate demand for more desirable goods in environmental terms, and consequently to make manufacturers supply goods that live up to such expectations. Accordingly, the following functions of eco-labelling can be distinguished: ecological, informative, stimulative, marketing, and educational. However, the fundamental role of eco-labelling is to assist consumers in recognizing environmentally-friendly products since co-labelling refers to every recognizable symbol affixed to a product or its packaging indicating that a company or product has achieved a certain level of effectiveness and efficiency in terms of environmental friendliness (S. Lin et al., 1945; Mufidah et al., 2018). Within this context, eco-labelling is regarded as one of the best tools for promoting organic products and influencing consumer-buying decisions (Aertsens et al., 2011; Smith and Paladino, 2010; Yau, 2012).

Nilsson et al. (1999) imply that eco-labels featured on products in stores constitute a key source of consumer information on the environmental impact of a product. The process by which eco-labelling informs the consumer of the need for ecological awareness and encourages sustainable consumption, is rarely studied. In our model focused, which is focused on sustainable consumption, apart from environmental criteria (referred to as ecological criteria) we have also attempted to distinguish vital criteria for consumer purchasing prerequisites. That is why our model takes into account price, quality, capacity, and environmental impact.

2.2. Sustainable production and sustainable consumption

Business operations, in particular production, entail the consumption of natural resources. The relationship between a company and its environment is based on the implied expectation that a company's adverse environmental impact is mitigated at every stage of production and consumption (Álvarez, 2018; Tatić et al., 2018). Therefore, it is important to adjust given business operations and their volume to existing environmental conditions, to manage natural resources and manufacture products rationally, to use products in a manner that will not threaten the environment (Wu et al., 2019). Environmental protection requirements have a considerable impact upon enterprises, simply due to the binding legal regulations governing this fact (Jose et al., 2020). However, environmental protection is perceived as a source of additional expense, e.g. enterprises must take into account in their budgets rising environmental use costs and environmental protection outlays. Thus, the modern management of a company should perceive environmental protection as an integral element of the management process (Haldar, 2019). In order to meet demand, companies are manufacturing more and more products, which in turn entails the need for more resources, materials, energy, water, fuel, and other consumables necessary for production purposes (Gong et al., 2019).

Given this background, unsustainable consumption, which is accelerating in parallel with the pace of industrialization, is regarded as one of the major causes of environmental degradation. The volume of solid waste, including post-consumption household waste, is also growing at a distressing rate (Eisenmenger et al., 2020). Increased consumption and the vast volume of new products emerging in the market each year combined with a reduced product lifespan translates into increased consumption of raw materials, energy, and a higher volume of solid waste produced by agglomerations and other residential areas. Excessive economic expansion is pushing up living standards in large social groups and creating new means of consumption, such as mega-, hyper- and supermarkets, cruise ships, fast food bars, distance selling catalogues, credit cards, etc., and these factors are giving rise to so-called hyper-consumption (Stanev, 2017).

Unsustainable consumption and production patterns are having an ever greater impact not only on the environment, but also on society, the economy, and enterprises (Cao et al., 2014). Hence, it is important for consumptionism, that is the driving force behind the implied changes, to pursue gradual sustainability in harmony with sustainable development objectives. For this purpose, the traditional consumer who adapts to the market and has poor ecological awareness should evolve into a consumer who promotes individuality through greater consumer awareness, and who chooses products safe for the environment, namely products with eco-labels (Hoque, 2014). Changing consumer attitudes and developing ecological injunctions are long and difficult processes.

Ecological consumer attitudes, namely those factors shaping the demand and consumption model, are accompanied by a growing supply of ecological and environment-friendly. Manufacturers are increasingly turning to pro-ecological measures so as to meet the legal requirements for promoting goods, which translates into an increasing interest in lifestyle changes and developing the market for ecological products (Adekambi et al., 2015). The above analysis leads to the assumption that sustainable production and sustainable consumption entail more effective use of natural resources and energy as well as a reduction in greenhouse gas emissions and other processes with an adverse ecological impact (Kusch-brandt, 2019). The point is to manufacture and use products and services that ensure the least possible interference with the environment. Therefore, the goal of sustainable production and consumption will be to meet the basic demand for goods and services and concurrently to ensure a higher standard of living and a sufficient quantity of resources for future generations.

Sustainable production and consumption also entail observance of the principle of the 3 Rs (Reduction, Recycling, Reusing) connected with rational solid waste disposal management (Malik et al., 2016). Furthermore, product life cycle analysis plays an important role in helping achieve sustainable production and consumption (Schaubroeck et al., 2020). Other supporting tools include, inter alia, economic instruments such as ecological charges, ecological taxes or subsidies (Meissner et al., 2020).

In order to create a national model of sustainable production and consumption, a number of pre-conditions must first be met. One indispensable step is to gear production toward environment-friendly products and services, i.e. those based on eco-design (Hazarika and Zhang, 2019).

Another step is to ensure that such products are chosen by consumers. This is possible thanks to an eco-labelling system that facilitates producer - consumer communication (Bengtsson, 2018). However, consumers decide to buy products on the basis of a series of factors, including their knowledge, needs and habits, the influence of advertising and other sources of information, the supply and availability of products and affordability (Birg and Voßwinkel, 2018). At the present time, one factor that is gaining in importance in production decision-making is the impact a product has upon people and the natural environment. Modelling both a product and its production processes on ecological features requires the efficient flow, compilation, and evaluation of information at all stages of the production process. Evaluation methods that assess the relationship between the environment and a product will be considered relevant instruments in the development of ecological products. The pre-production phase, when the product concept and design are developed together with the technologies indispensable for the production process, is regarded as the beginning of the product life cycle. The upshot of the pre-production phase is the product design, the quality of which is determined by a specific set of features (including ecological ones), and a production process designed and based on specific technological advances. That is why eco-design may be treated as a compromise between ecological usability requirements, and technological feasibility (Laruccia & Garcia, 2015). Designing is a process that involves reasoning, especially ecology-oriented reasoning, which is used in the design of technical products, and which takes into consideration the ecological effects of their manufacture and usability (Buhl et al., 2019). The earlier environmental aspects are incorporated into the product design, the more effective it becomes.

Eco-design also plays an important role in the implementation of a company's environmental policy, which includes adapting to the criteria established for specific eco-labelling. According to Directive 2009/125/CE [Directive 2009], eco-design involves the regular incorporation of the environment life cycle perspective into the design of products, services, and processes. Eco-design entails embedding environmental aspects in the product design with the aim of improving its eco-effectiveness throughout its life cycle. The eco-design process results in an environmental profile describing outlays and products related to a given product throughout its life cycle that are significant from the point of view of its environmental impact and are expressed in measurable physical terms (Pigosso et al., 2017).

Continual modifications can be observed in the extent to which a company perceives its role in economic development and its importance in satisfying comprehensive social needs and requirements. New phenomena in the domain of consumption, production, and cooperation between respective market participants have given rise to some very dynamic and interdisciplinary issues. Not only the state but also other market participants, including (circular) companies (Tunn et al., 2018), need to take measures aimed at, among other things, promoting environmental protection. That is why it is so important to raise ecological awareness and foster a modern image of efficient economic processes based on ethical and ecological components (Nikolaou et al., 2018).

3. Research methodology

3.1. Applied method

The AHP (Analytical Hierarchical Process) method was employed to assess the impact of eco-labelling on the implementation of sustainable production and consumption. The choice of method came from the following publications (Wątróbski et al., 2019).

Empirical data were gathered and analyzed using the pairwise comparison method which makes it possible to assess preferences (significance) regarding elements or criteria in the relational database as well as to determine both the most effective/beneficial procedure option as well as the influence of those criteria/elements. Pairwise comparison, referred to as *PC* in the subject literature, is not a new method. It is believed to have been used for the first time by the 13th-century philosopher Ramon Lllul within the context of social choice theory and the theory of electoral systems. His version was based on simple binary comparisons (Colomer, 2013). Over the centuries Lllul's method has been improved upon by numerous scholars such as, for instance, the 18th-century French mathematician and philosopher Nicolas de Condorcet (Saari, 2009). It has also been modified by contemporary researchers, inter alia, Louis L. Thurstone, Y. Takane, R. D. Luce and R. A. Bradley & M. E. Terry (Kułakowski et al., 2019).

The PC method entails specifying items contained in a given paired set and then determining which of the two items is preferred. This means that only two items are analyzed at the same time. After studying all combinations of such pairs, it is possible to determine which of them is the most preferred, which are less preferred, and so on and so forth. Probably the best-known applications of the PC method are two multiple-criteria approaches: the Analytic Hierarchical Process (AHP) and its extension, the Analytic Network Process (ANP). Both methods were developed in the 1970s by the American mathematician Thomas L. Saaty with the aim of facilitating decision-making processes (Saaty, 2008). Apart from the AHP/ANP, the PC method has also been incorporated into other multiple-criteria methods, e.g. *ELECTRE*, *PROMETHEE* or *MACBETH*. Comparing these methods, *AHP/ANP* offers a comparatively easy determination of spcific values that reflect the preference of one item over another (Kułakowski, 2016).

3.2. Stages and mathematical basis of AHP

The AHP method is a research procedure that usually consists of the following four stages (Fig. 1): 1) building a decision-making model in the form of a hierarchical structure; 2) gathering original data by means of the pairwise comparison scale 1–9 (also called the fundamental scale; 3) estimating weight coefficients, namely defining a priority vector for each matrix of comparisons; 4) aggregating judgments or priorities in group decision-making; 5) controlling consistency and assessing the sensitivity of the results. The whole process can be found in the publications by T.L. Saaty (2002).

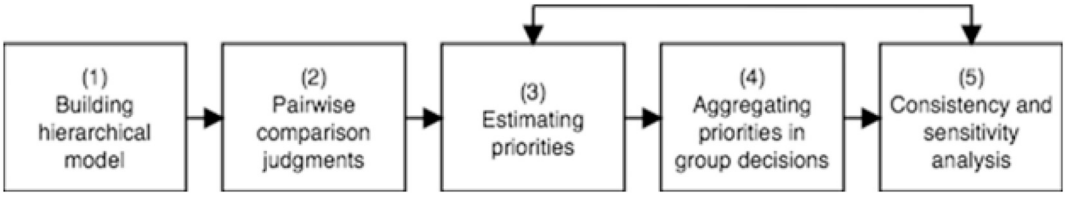

Fig. 1. Stages of the AHP.

Ad 1)

In the case of the AHP method, hierarchical models are built by breaking down the decision-making problem into smaller items, grouping those items into homogenous clusters and subsequently ranking the clusters within the framework of a hierarchy, according to the relationships existing among them. The AHP model that is most often found in the related literature is a hierarchical structure comprising four levels: the decision-making goal located at top of the hierarchy, the decision-making criteria (also referred to as immediate goals), the sub-criteria describing respective criteria and, ranked lowest in the model, decision-making options.

Ad 2)

This ready-made hierarchical model requires analysis within the framework of the AHP method. This analysis is performed by means of a bipolar scale of pairwise comparisons, called *Saaty's fundamental scale* or *9-point pairwise comparison scale*. That scale allows us to measure 9 ranks of preferences of one item in relation to another, from "1 "(both items are equally significant) to "9 "– one item is clearly and unequivocally preferred to another. A higher rank may be also expressed in terms of preference, probability or the volume of a given feature in an object, depending on the kind of a decision-making problem involved and comparable objects. While making pairwise comparisons in the hierarchical model, the analysis needs to maintain consistency of direction such that, in the case of the AHP method, it always proceeds from top to bottom, namely items ranked lower are compared with one another within the same group in relation to a specific item ranked higher (superior item). All possible combinations (pairs) of items must be taken into account within each group (cluster) in the hierarchical structure.

Ad 3)

The *pairwise comparison matrix = PC matrix* is the fundamental tool used to analyze data based on the AHP method. It is supplied with the results of comparisons between respective items expressed in terms of the fundamental Saaty scale, after which they are the subject of a mathematical analysis. The pairwise comparison matrix is usually marked with symbol *A* and takes the following form (the equation formula (3.1)):

$$A = [a_{ij}] = \begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} \end{bmatrix} = \begin{bmatrix} 1 & a_{12} & \dots & a_{1n} \\ \frac{1}{a_{12}} & 1 & \dots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ \frac{1}{a_{1n}} & \frac{1}{a_{2n}} & \dots & 1 \end{bmatrix} \quad (3.1)$$

The respective values in matrix A (a_{ij}) refer to the extent to which (how much) element x_i is *preferred* to x_j with respect to a given feature (criterion, goal, etc.) that is a higher ranked item (superior item). For each such matrix, the so-called *vector of preferences* is determined. The latter is most often referred to as a *priority vector* or *a weight vector*, and in the related literature is marked with the letter *w*:

$$w = [w_1, w_2, \dots, w_n]^T \quad (3.2)$$

It represents the rank of decision-making criteria or options according to their relative significance or preference. From among at least a dozen or so methods for defining the priority vector, the most often uses is the *right eigenvector method,* recommended by Saaty. Other methods of defining the weight vector, which are also willingly applied by researchers include the *logarithmic least square method LLSM*, also referred to as the *geometric mean method - GM*), and the *normalized columns method*, namely the *arithmetic mean method* (Stein and Mizzi, 2007). The result of comparisons between item x_i and item x_j is inversely symmetrical to comparisons between x_j and x_i, As a consequence, such a matrix is called the *reciprocal matrix*. This means that each of its items complies with the characteristics described by means of equation formula (3.3):

$$a_{ji} = \frac{1}{a_{ji}} \forall i, j = 1, \dots, n \quad (3.3)$$

where $a_{ii} = 1$ for each $i = 1, 2, \dots, n$.

The higher the value of the weight coefficient, the more significant and more influential it is for the criterion in question. The AHP method consists of two kinds (ranks) of weight coefficient: *local priorities* and *global priorities*. These are related to the location of priorities in the hierarchical model and to the decision-making goal. Local priorities are the values of the priority vector and reflect the significance of a given item in relation to the matrix-based item (i.e. ranked one level higher in the hierarchical structure). Global priorities present the percentage share of each item during the process of achieving the overall goal. For instance, global weights for sub-criteria are estimated as the product of their local weights and the weights of their higher-ranked matrix-based criteria.

Ad 4). The AHP method-related literature very often refers to *group decision-making*. Four sequential paths of aggregating judgments may be differentiated, and these are as follows (Dyer and Forman, 1992): consensus, voting, aggregating individual judgments – AIJ, and aggregating individual priorities – AIP. If a consensus cannot be reached or voting cannot be conducted, the AIJ or AIP procedure is applied. In the case of AIJ, independent matrices $A_1, \dots, A_m$ are combined to form one joint matrix: $A^G = (a_{ij}^G)$ and only afterwards is the priority vector estimated. In this case aggregation *precedes* the estimation of priorities, so in reality it is an *aggregation of comparisons.* The *AIJ* is applied when several decision makers act synergically like a uniform team. In such a situation they may be treated as a single person - a decision maker (Forman and Peniwati, 1998). In the case of the AIJ procedure, the geometric mean is recommended (Aczél and Saaty, 1983). In the case of the AIP procedure, for each independent matrix (each respondent) the priority vectors are computed independently: $w_1, \dots, w_m$. Subsequently, they are aggregated into one joint vector w^G. In this case aggregation *follows* the estimation of priorities. This approach is usually adopted when the respondents are not members of a uniform team and/or provide answers at different times. The AIP procedure requires an independent analysis of the models of various respondents, which in the majority of cases is much more time-consuming than the *AIJ* procedure. Both the weighted geometric mean and the arithmetic mean may be used to aggregate the weight coefficients. The results of the studied discussed in this article were aggregated by means of the AIP procedure, and the priority values presented here were computed by means of the arithmetic mean.

Ad 5) Consistency is an important attribute of each comparison matrix. If a matrix is consistent, it means that the respondents answered thoughtfully rather than randomly and the consistent results are synonymous with their credibility. With regard to the mathematics, a

matrix is consistent when:

$a_{ik} = a_{ij} \cdot a_{jk}$

for each *i, j, k = 1, …, n.*

In the related literature a series of indices are proposed for the purpose of quantifying the size of this deviation. The indices most often applied in the AHP method are the *Consistency Index* and its normalized version, namely the *Consistency Ratio*. That index was proposed by Saaty in combination with a method that involved estimating weights by means of the *right eigenvector method* (*EV*). Consistency was measured based on the assumption that the ideal consistency of a square matrix of comparisons of *n* items ($A_{n\times n}$) is sustained when its highest *eigenvalue* (λ_{max}) is equivalent to the number of compared items *n*, namely (Thomas L. Saaty and Vargas, 1985):

$\lambda_{\max} = n$for all $a_{ij} = \frac{w_i}{w_j}$.

This means that the more λ_{max} approximates the value *n*, the more consistent the matrix is (Alonso et al., 2006). Saaty also proved that inconsistent matrices have values λ_{max} higher than *n* (Dadkhah and Zahedi, 1993). The deviation from the ideal consistency is measured by means of *consistency index CI*, according to the following equation formula:

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

where $\lambda_{\max} - 1$ is the deviation of all a_{ij} from estimated values$\frac{w_i}{w_j}$, namely the deviation from the ideal consistency.

The simulations indicated that the expected value of the *CI* of randomly generated matrices of dimension n + 1 is on average higher than the expected value of the *CI* of the matrix of dimension *n*. This implied that the *CI* is more restrictive for matrices of higher dimensions and it must be rescaled. In this way we arrive at consistency ratio *CR*, which is the normalized value of the *CI*. It is determined by dividing the *CI* by the so-called *Random Index (RI)*:

$$CR = \frac{CI}{RI}.$$

The *RI* is the arithmetic mean of the *CI* for the large number of randomly generated matrices of varied dimension *n*. They are depicted as constant, tabulated values for $n = 3, \ldots., 15.$, which must be supplied to the aforementioned equation formula (Alonso et al., 2006)(Alonso and Lamata, 2006). According to Saaty:

- matrix *A* is utterly (ideally) consistent if $CR = 0$,
- almost consistent (or: inconsistent within permissible limits) if $0 < CR \leq 0{,}10$,
- matrix A is not consistent if $CR > 0{,}10$.

Although $CR = 0{,}10$ is the limit value for a matrix to be considered consistent (Saaty, 1980), many scholars criticized this level as too restrictive and arbitrary (Golden and Q. Wang 1989). It is also difficult to obtain judgments regarding more than three elements compared at a time (Lane and Verdini, 2007). Moreover, Saaty himself emphasized that minimizing the CR should not be a purpose in itself. However, in the case of matrices with a CR significantly exceeding the level of *0.10* (specifically *0.20* and more), the judgments should be repeated (Apostolou and Hassell, 2002).

In addition to the consistency of matrices, sensitivity analysis should be conducted to see how the priorities of the alternatives change as we vary the criteria or subcriteria. By changing the weight of each criterion, one can check if the initial rank order of alternatives is likely to reverse (Saaty, 1980). It is particularly important when the judgments for some criteria may be subjective, or the preference judgments come from a group decision, where individual opinions were merged (Steele et al., 2009).

3.3. Research process

The first stage of the research process was the questionnaire-based survey conducted among both entrepreneurs ($N = 50$) and consumers ($N = 250$). The companies were recruited from the following branches of industry: food, textiles, construction, cosmetics, and home appliances, as these are the leading branches of industry on the ecological products market, based on the following report: “Environmental labelling and information schemes”. What is important is that the consumer group was represented by customers from the surveyed branches, with 5 customers from each.

Within the framework of the present survey, the representatives of the entrepreneurs (managers) were requested to indicate the criteria they regarded as significant for assessing the influence of eco-labelling upon the implementation of sustainable production. On the other hand, in the consumer surveys the respondents (the customers of the surveyed entrepreneurs) were requested to indicate the key criteria determining their choice of purchased products. All of the above served as the basis for shortlisting the key criteria for developing the AHP models.

The next step was to conduct interviews with the representatives of enterprises ($N = 10$) and their consumers ($N = 50$) by means of an interview questionnaire. All the data were compiled by means of the paired comparison method based on specially prepared pre-set AHP questionnaire. The respondents’ assessments of the significance of different factors were gathered from the respondents’ principal offices, with each respondent being interviewed separately under the supervision of a moderator. The duration of a single interview ranged from 10 to 20 min. The CR was computed for each respondent. In compliance with the assumptions underlying Saaty’s method and for the purpose of concluding the analysis of the AHP model, a resulting CR below 10% was exclusively applied, i.e., $n = 8$ for enterprises, and $n = 42$ in the case of the consumers.

Analysis of the decision-making problem by means of the aforementioned method comprised two phases, i.e. the development of a hierarchical structure of a decision problem and the assessment of grouped items. Three models were developed for analytical purposes: (1) a model measuring the impact of eco-labelling on sustainable production, (2) a model describing the impact of respective factors on a consumer’s choice of product, and (3) a model (combining the two previous ones) evaluating the need for mandatory eco-labelling on products.

The assessment was based on a comparison of pairs of all the items at a given hierarchical level from the point of view of each individual item located at a higher level.

The hierarchical model was designed and then properly analyzed in the form of a comparative analysis conducted of pairs of all possible pairs of items created within a particular group. As a consequence, all possible pairs of items in respective groups in the hierarchical model were first established (at the same time creating an appropriate questionnaire), and then research was conducted in which the respondents in the two studied groups (producers and consumers) analyzed the items, comparing them in pairs. Each item was assessed by comparing them with a higher ranked item. The relationships between respective items were determined on the basis of Saaty’s 9-point scale: 1 - equal significance; 3 - weak, small advantage; 5 - strong advantage; 7 - very strong advantage; 9 - absolute, total advantage; 2, 4, 6, 8 - intermediate values. By means of this scale, the respondents indicated which of the two comparable items with a feature in common gained superiority due to that feature. As a next step, these judgments were analyzed using SuperDecisions software individually for each respondent in order to derive weights (priorities). Individual priorities were then aggregated using the AIP procedure based on arithmetic mean.

The first group of respondents employed the opinions and experiences of the management at various levels as well as of the units involved directly or indirectly in the management of an enterprise, in

particular the people responsible for the environmental aspects of the company's management. The goal of the study was to assess the relevance of the environmental rationale in product decision-making within companies.

The second group of respondents used consumer opinions on eco-labelling in the context of consumers' purchase decisions.

To verify the consistency of the results.

obtained from pairwise comparisons, consistency indices (*CI*) and respective consistency ratios (*CR*) were calculated individually per respondent for each PC matrix. Due to the large number of matrices it is impossible to report CR values individually. Matrices with a CR greater than *0.10* were excluded from further analysis, in accordance with to Saaty' recommendations, as was explained in the section 3.2 above.

3.4. Survey results

3.4.1. Empirical study of producers

From the point of view of the research, the crucial task was to determine the degree of eco-labelling implementation so as to identify its influence on the accomplishment of sustainable production. The study also encompassed the prerequisites determining the ecological measures undertaken as part of an enterprise's product policy. With this aim in mind, the entrepreneurs who took part in the survey were asked to assess the impact of eco-labelling on achieving sustainable production objectives by means of a 5-point grading scale, where 1 meant there was no impact and 5 - a very considerable impact. Some 36% of the surveyed entrepreneurs assessed the impact as average. Another 12% believed there had been no impact, whereas only 4% judged this impact to be considerable (Fig. 2.). The distribution of responses indicates that, according to the surveyed representatives, eco-labelling is an underestimated tool, a fact which is evident above all in the limited extent of its implementation.

To assess the impact of eco-labelling upon the implementation of sustainable production and sustainable consumption, the ecological prerequisites for product decisions made by enterprises were also surveyed. The starting point was to determine the significance of general categories of prerequisites in the product decision-making process. With this aim in mind, the surveyed representatives were requested to indicate key prerequisites and to judge them by means of a 5-point grading scale, where: 1- a category is disregarded, 5 – a category is regarded as the most significant in the decision-making process.

Based on our analysis of the different categories of prerequisites in product decision-making, it is plausible to argue that the predominant role is played by economic prerequisites and related market prerequisites (the hierarchy of significance was based on the weighted average of the judgments, and weights were assigned according to a graded points scale where 1 = factors regarded as insignificant and 5 = factors judged to be very significant). Legal prerequisites were also significant. These categories are strongly correlated, and thus it is not surprising that they are similarly assessed. An enterprise that does not pay pecuniary penalties, e.g. for non-compliance with environmental standards, can expect a higher net income. Considering the competitiveness arising from market prerequisites, this may also positively

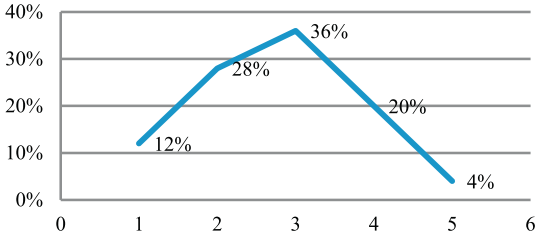

Fig. 2. An assessment of the impact of eco-labelling upon the achievement of sustainable production objectives.

translate into economic prerequisites. Marketing, technological, and ecological prerequisites make up the second group of prerequisites taken into account in the product decision-making process, and also represent relationships. Human resources and environmental certificate requirements were assessed by the surveyed representatives to be the least significant categories (Fig. 3).

3.4.2. Empirical study of consumers

The consumers were asked in the survey to specify what was most important for them when buying products. Half of them considered price to be the most significant factor when choosing products. Quality was the second-ranked factor - 37%. However, 8% of the surveyed consumers considered the capacity of the chosen product to be most important. Only 5% of them were influenced by the environmental impact of a product when making a purchase (Fig. 4).

An analysis of the survey results indicates that the purchasing decisions of one in every two consumers were driven by price. This judgement is confirmed by the responses to the next question in the survey regarding the affordability of buying higher-priced organic products, as 75% of the consumers said they did not intend to pay more for organic products, while a mere 9% of the respondents regarded such products as affordable. The remaining group of respondents declared that their choice depended on the product, and, interestingly enough, all of them were in a position to pay more for food products. In the opinion of 78% of the surveyed consumers, organic products were more expensive than traditional ones. On the other hand. 12% did not notice any difference and 10% had no opinion on this matter.

4. Research results

4.1. Model showing the eco-labelling impact on sustainable production

The AHP multi-criteria method was used to determine the impact of eco-labelling on sustainable production (Model 1). This model was developed to assess the importance of particular groups of criteria affecting the extent of eco-labelling implementation in the surveyed companies. The structure of the model identified the quoted main objective, main criteria, sub-criteria and scenarios, assuming the level of eco-labelling impact on sustainable production. The following main criteria were distinguished on the basis of the company survey: economic, market, marketing, technological, ecological and human resources. The AHP multi-criteria method was used to determine the impact of eco-labelling on sustainable production. This model was developed to assess the influence of particular groups of criteria in the application of eco-labelling in the surveyed companies. Under the model structure, the main objective, the main criteria, the sub-criteria and the scenarios assuming the level of eco-labelling impact on sustainable production were identified. The following main criteria were distinguished on the basis of the company survey: economic, market, marketing, technological, ecological and human resources.

To provide more accurate data on the companies that make use of eco-labelling, the model also takes into account sub-criteria representing respective factors for each criterion. In the case of economic criteria, we distinguished the sub-criteria determining the level of expenditure on implementing eco-labelling according to the following scale: very significant, significant, average, low, very low. The significant sub-criterion found in the market criterion was the increase in the company's credibility in the eyes of customers. When it comes to the marketing criterion, the focus was on determining whether there was an increase in sales of products/services after the implementation of environmental labelling. The degree of difficulty experienced by a company in adapting to eco-label criteria was the sub-criterion taken from the technology group. For this purpose, the following scale was adopted: very easy, easy, medium, difficult, very difficult. Meanwhile, the most important ecological sub-criterion adopted was whether the surveyed companies had applied the ISO standards of the 14,020 series when

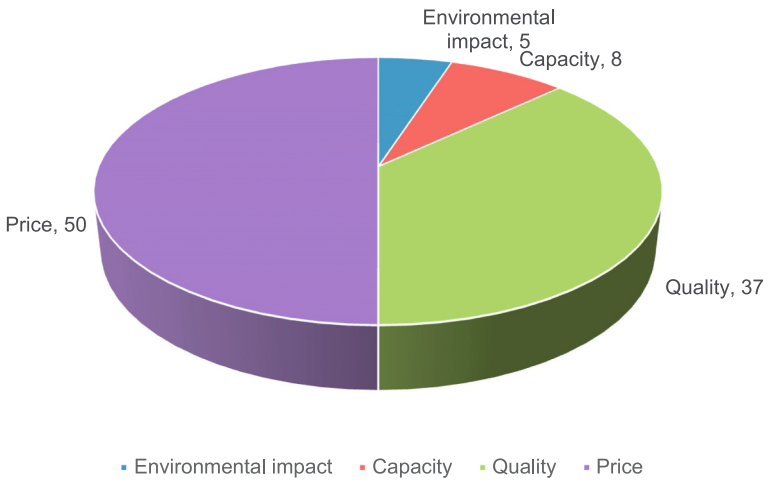

Fig. 3. Prerequisites in the product decision-making of enterprises.

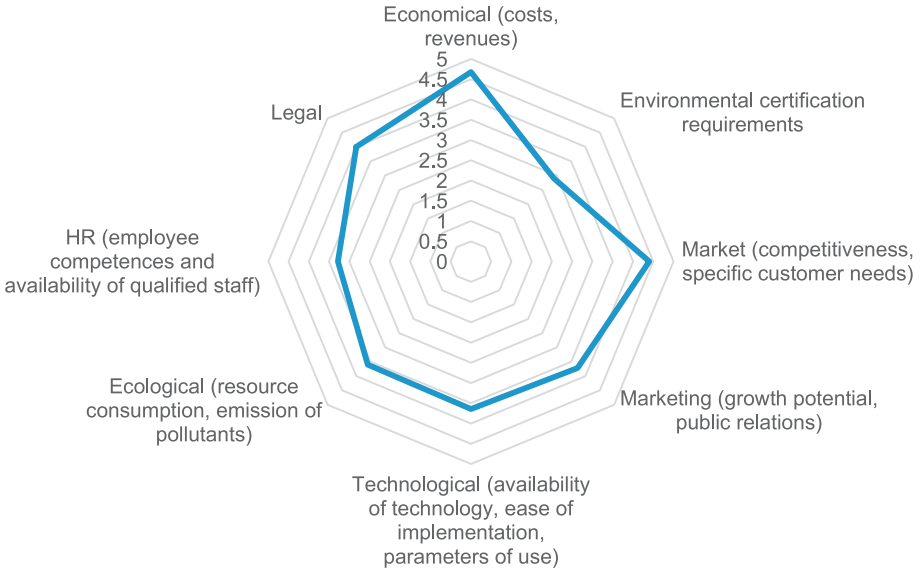

Fig. 4. Consumers' product choice criteria.

implementing eco-labelling. The key sub-criterion in the case of human resources was the extent to which the surveyed companies have adjusted to the criteria of the adopted eco-label. It was considered appropriate to define such an adjustment as follows: self-adjusting through outsourcing after the input data has been prepared and outsourcing the entire procedure to an external institution.

The adopted alternatives were determined on the basis of the impact of eco-labelling on sustainable production, and were defined as follows: no impact, low impact, medium impact, high impact, very high impact. Table 1 presents the values of local and global priorities for respective factors.

The local priority values calculated for the main criteria indicate that market criteria are the most important in determining the implementation of eco-labelling in the surveyed companies. The local priority in their case is 0.2077. This group is followed by marketing criteria (0.1932). Other sets of criteria with similar local priority values are ecological (0.1787) and technological (0.1690). The lowest importance is attached to economic (0.1304) and HR (0.1207) criteria.

The market sub-criterion, namely the increase in a company's credibility in the eyes of customers following eco-labelling implementation, reveals that companies that achieved enhanced credibility had higher local priority values (0.6666). Unfortunately, this increase in credibility does not translate into an increase in sales of products/services in the marketing sub-criteria group. The absence of any recorded increase in sales translates into a local priority value of as high as as 0.9987, which may directly reflect a low level of eco-labelling in the companies covered by the study. Although ecological criteria are relatively important at the main criteria level, the calculated priorities at the sub-criterion level may come as a surprise. The failure to apply the ISO standards of the 14,020 series during eco-labelling implementation results in a local priority value of 0.8333 in this case. The degree of difficulty that a company experiences in implementing the applied eco-label criteria is included among the technological sub-criteria. The same local priorities are calculated for medium and difficult levels of adjustment in the indicated group (0.4987) as well as for very easy, easy and very difficult levels (0.0008). The level of expenditure incurred on the implementation of eco-labelling is highlighted among the economic sub-criteria. Taking into account the proposed scale, the highest local priority (0.3327) is allocated to high, low and very low financial expenditure. Subsequent local priorities with a value of 0.0008 were calculated for very high and medium expenditure. The final sub-criteria group, which includes human resources criteria, measured how much a

Table 1
Priority values for the eco-labelling impact model showing the implementation of sustainable production.

Criteria	Priority	Subcriteria	Local	Global
Economic	0,1304	The value of financial expenditure incurred on the implementation of eco-labelling:		
		very high	0,0008	0,0001
		high	0,3327	0,0434
		medium	0,0008	0,0001
		low	0,3327	0,0434
		very low	0,3327	0,0434
Market	0,2077	An increase in a company's credibility in the eyes of customers following the implementation of eco-labelling:		
		Yes	0,6666	0,1385
		No	0,3333	0,0692
Marketing	0,1932	An increase in sales of products/services following the implementation of eco-labelling		
		Yes	0,0012	0,0002
		No	0,9987	0,1929
Technological	0,1690	The degree of difficulty faced by a company in adapting to the criteria of an applied eco-label:		
		very easy	0,0008	0,0001
		Easy	0,0008	0,0001
		Average	0,4987	0,0843
		Difficult	0,4987	0,0843
		very difficult	0,0008	0,0001
Ecological	0,1787	The ISO standards of the 14,020 series were applied when implementing eco-labelling in the company:		
		Yes	0,1666	0,0298
		No	0,8333	0,1489
HR	0,1207	The company adjusted to the criteria of the applied eco-label:		
		on an individual basis	0,6666	0,0805
		The procedure was outsourced after the input data had been prepared	0,1666	0,0201
		the entire procedure was outsourced to an external body	0,1666	0,0201
Alternatives - impact of eco labelling on sustainable production:		no impact		0,1303
		low impact		0,1646
		medium impact		0,4404
		high impact		0,1303
		very high impact		0,1344

Individual CR ≤0,00;0,10) (matrices with CR≥0,10 excluded from the analysis).

company has adjusted to the criteria of the eco-labelling used. The local priority with the highest value, of 0.6666, indicates that a company was able to adjust independently to the required eco-labelling criteria. The local priority for the partial and total adjustment procedures was 0.1666 each.

In light of the above calculations, the goal of which was to determine the impact of eco-labelling on sustainable production through the highest priority value (0,4403), and thus distancing from the other scenarios, the indicated level was assessed as average. In the second place, it was regarded as small (0,1646). In the other scenarios, which obtained priority values of 0.1303 each, this level was rated as very high, high and without any impact.

4.2. The consumer product choice in terms of respective factors' influence model

The model was developed in order to reflect consumer behavior when making purchasing decisions and the model calculations were based once more on the *Super Decision* program. The main objective, main criteria, sub-criteria and alternatives were highlighted in the model In accordance with the requirements of the hierarchical method of multi-criteria decision-making.

The model was developed to reflect the behavior of consumers when making purchasing decisions (Model 2). The main objective, main criteria, sub-criteria and alternatives were distinguished in the analyzed model in accordance with the requirements of the hierarchical method of multi-criteria decision-making. The main criteria include those factors which consumers most often take into account when choosing a product, i.e. price, quality, environmental impact and packaging/product capacity. In the case of the sub-criteria, consumer opinions regarding the ecological features of products were taken into account, i.e. whether, in their opinion, ecological products are more expensive than traditional ones, are of higher quality and are safer for the environment. A decision to purchase a product also depends on the size/capacity of the packaging. According to the model, organic products are assumed to be eco-labelled products. The model under consideration shows how far the main criteria and sub-criteria are translated into consumer choices to purchase products with eco-labels. The local and global priorities were obtained on the basis of AHP calculations. They are presented in detail in Table 2.

The price of a product (a share of 0.5000 in reaching the main goal) is the decisive factor influencing product choice in the main criteria group. Quality is the second most important factor with a local priority value of 0.2077. Another factor taken into account, although one that is much less important, is packaging/product capacity, with a local priority value of 0.0800. Unfortunately, the consumers who took part in the survey paid the least attention to the environmental impact of the products they purchased. In this case the local priority value is only 0.0480.

Within the sub-criteria group connected with the product price criterion, a local priority value of 0,8666 indicates that organic products are perceived by consumers to be significantly more expensive. The local priority value, which assumes that the price of organic and traditional products is the same, is only 0.1333. Assumptions regarding product quality constitute another analyzed sub-criterion. In this case the local priority values are very similar. A slightly higher priority value, i.e. 0.5764, was calculated for the statement that organic products are not higher in quality than other products. In the sub-criteria group connected with a product's impact on the environment, the clear advantage of the local priority (0.8064) indicates a perception among respondents that ecological products are much safer. The local priority value also has a slight advantage in the next group of analyzed sub-criteria, i.e. packaging/product capacity as perceived by the surveyed consumers. A local priority value of 0.7944 was given to products in larger packaging. It should be pointed out here that criteria concerning the environmental impact of a product as well as its packaging/product capacity are assigned far less importance in product selection, according to the presented model.

The above-mentioned calculations indicate that eco-labelling had a relatively average impact on sustainable consumption. The priority value analysis shows that, taking into account the indicated criteria and

Table 2
Priorities shaping consumer product choice reflected in the model showing the influence of different factors.

Criteria	Priority	Subcriteria	Local	Global
Price	0,5000	Eco-products are more expensive:		
		Yes	0,8666	0,4333
		No	0,1333	0,0667
Quality	0,2077	Eco-products are of higher quality:		
		Yes	0,4235	0,1567
		No	0,5764	0,2133
Environmental impact of the product	0,0480	Eco-products are safer for the environment:		
		Yes	0,8064	0,0387
		No	0,1935	0,0093
Capacity	0,0800	Package/product capacity:		
		I choose products in large packaging	0,7944	0,0636
		I choose products in small packaging	0,2500	0,0200
Alternatives - the influence of respective factors on consumer product choice:		A product with an eco-label		0,3655
		A product without an eco-label		0,6344

Individual CR ≤0,00;0,10) (matrices with CR≥0,10 excluded from the analysis).

sub-criteria, the respondents were more likely to choose products without eco-labels (0.6344). A priority value of 0.3655 suggests less preference for products with eco-labelling.

In the light of the above calculations, the fact that consumers perceive organic products to be more expensive than other products has a very negative impact on purchasing decisions vis a vis such items. This fact may also be attributed to the relatively lower number of products with eco-labels available compared to the number of products without eco-labels. Although the consumers taking part in the survey tended to regard products with eco-labels as much safer, they very rarely made purchasing decisions based on the environmental impact of a product. The low level of consumer eco-awareness is evident in the noticeable contradictions in their responses, as although they consider organic products to be safer, they do not necessarily view them as being of higher quality.

4.3. Model in terms of sustainable production and consumption

The need to manufacture products with a limited environmental impact increases with the number of goods produced. Unfortunately, despite the numerous benefits resulting from the application of eco-labels, the research carried out reveals both a low level of eco-labelling implementation in companies and only limited recognition among consumers. Due to the current situation, the present study attempts to analyze corrective solutions. For this purpose, the multi-criteria AHP method was applied once more, which, thanks to the quantitative data from the conducted surveys, will make it possible to select the best solution.

In order to create a proper structure hierarchy in the decision-making process, the proposed model again distinguishes between the main objective, criteria, sub-criteria and alternatives, which constitute scenarios for solutions to the problem under consideration. Based on the analysis of the related literature and the results of the survey, the main objective has been to identify opportunities for increasing the importance of eco-labelling in achieving sustainable production and consumption (Model 3). The proposed solution entails introducing mandatory consumer information on the environmental impact of the product throughout its life cycle. Two key market players, which are fundamental to sustainable production and consumption, i.e. producers and consumers, have been identified to make up the main criterion. In the context of environmental labelling they are of equal importance and therefore their local priorities are set at a level of 0.5. However, the decisions of producers and consumers are influenced by various factors, which in the model are defined at a sub-criteria level. From a labor point of view, the price, quality, environmental impact and capacity of a product are considered to be the most important incentives shaping consumers' purchasing decisions. In turn, economic, market, marketing, technological, environmental, personnel, legal and environmental certification requirements are identified as key factors influencing the product decisions made in companies.

Super Decision software was applied to calculate the model. In the analyzed model, the main criteria have been assigned the same priority (significance). Differences are visible when comparing the values of priorities at the sub-criteria level relating to the main criteria. Table 3 presents a summary list of priorities of the main criteria, sub-criteria and alternatives that are scenarios for solutions for the AHP model of applying eco-labelling to sustainable production and consumption.

The differences between the values of the various solution scenarios indicate that eco-labels should be applied to products/services on a mandatory basis so that eco-labelling can make a greater contribution to sustainable production and consumption. The priority value for this solution is 0.6130. This result is strongly influenced by consumers, who are more likely to see the need for mandatory use of environmental labelling than producers. As a consequence, the analysis shows that only systemic solutions could facilitate the target-oriented implementation of eco-labelling.

Table 3
Local and global priority values for the eco-label application model in terms of sustainable production and consumption.

Criteria	Priority	Subcriteria	Local	Global
Sustainable consumption	0,5000	Price	0,5000	0,2500
		Quality	0,3720	0,1860
		Environmental impact	0,0480	0,0240
		Capacity	0,0800	0,0400
Sustainable production	0,5000	Ecological factors	0,1304	0,0652
		Economic factors	0,2077	0,1039
		HR factors	0,1932	0,0966
		Marketing factors	0,1690	0,0845
		Market factors	0,1787	0,0894
		Technological factors	0,1207	0,0604
Alternatives:		Mandatory use of eco-labelling on products/services		0,6130
		Optional use of eco-labelling on products/services		0,3870

Individual CR ≤0,00;0,10) (matrices with CR≥0,10 excluded from the analysis)

However, further research is needed in the form of a cost-benefit analysis of the applied solutions, which may highlight the importance of the analyzed scenarios to a greater extent and lead to greater optimization.

4.4. Sensitivity analysis

Sensitivity analysis was performed in Super Decisions v. 2.9 for each model (Model 1, Model 2, Model 3), after the aggregation of priorities calculated for individual respondents. The results were similar, therefore we present the sensitivity results for Model 3, which comprises sustainable production and consumption (Table 4).

It can be observed that in almost all cases, by shifting the current value of priorities for subcriteria, there is no change in rank of alternatives. Figs. 5 and 6 have been shown as examples. The results show that shifting the value of Price has no effect on ranking of alternatives (see Fig. 5). Similar behavior is observed for the remaining subcriteria, except for Marketing, for which rank reversal happens when its weight exceeds 85% (however, the current priority value of Marketing is 8,45%).

Based on the above sensitivity analysis, it can be concluded that the results are stable, and the final decision is reliable and consistent.

5. Discussion and conclusions

Assuming that sustainable development is a restructuring program aimed at fostering social, technical and economic links based on fostering respect for the environment, this concept forces existing organizations to renew themselves. It creates new opportunities to act in ways that ensure that the current generation's commitment to future generations by promoting a greener society and economy is fulfilled once more.

However, sustainable development will not be achieved without transforming consumer societies into sustainable ones, because although on the one hand increased demand affects growth in terms of the sale of goods and services, which brings businesses profits, on the other, indirectly it affects the ecosystem in a negative way. Therefore, balancing economic objectives with environmental and social objectives poses a major challenge not only for contemporary producers, manufacturers and consumers, but also for governments, social organizations and other economic players (Eisenmenger et al., 2020).

The ability to combine the laws of ecology and economics with decision-making processes is one of the key factors pre-conditioning sustainable development (Fernandes et al., 2020). It is important to ensure this process is sustainable at all institutional levels, i.e. in households, companies and in international agreements and treaties between states (Bertrandias et al., 2017) (Sebestyén et al., 2020).

Table 4
Sensitivity analysis for alternatives - obligatory labelling (obl **0,613**), optional labelling (opt **0,387**) with respect to the subcriteria (Model 3).

Par	1.1ecol0 .0652		1.2econ0 .1039		1.3HR0 .0966		1.4mktig0 .0845		1.5mark0 .0894		1.6techn0 .0604		2.1price0 .2500		2.2qual0 .1860		2.3envir0 .0240		2.4capac0 .0400	
	obl	opt	obl	opt	obl	opt	obl	opt	obl	opt	obl	opt	obl	opt	obl	opt	obl	opt	obl	opt
0.00	0.59	0.41	0.64	0.36	0.61	0.39	0.64	0.36	0.60	0.40	0.60	0.40	0.64	0.36	0.60	0.40	0.61	0.39	0.61	0.39
0.05	0.59	0.41	0.63	0.37	0.61	0.39	0.64	0.36	0.60	0.40	0.60	0.40	0.63	0.37	0.60	0.40	0.61	0.39	0.61	0.39
0.10	0.59	0.41	0.63	0.37	0.61	0.39	0.64	0.36	0.60	0.40	0.60	0.40	0.63	0.37	0.60	0.40	0.61	0.39	0.61	0.39
0.15	0.59	0.41	0.63	0.37	0.61	0.39	0.64	0.36	0.60	0.40	0.61	0.39	0.63	0.37	0.61	0.39	0.61	0.39	0.61	0.39
0.20	0.60	0.40	0.63	0.37	0.61	0.39	0.63	0.37	0.60	0.40	0.61	0.39	0.63	0.37	0.61	0.39	0.61	0.39	0.61	0.39
0.25	0.60	0.40	0.62	0.38	0.61	0.39	0.63	0.37	0.60	0.40	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.61	0.39
0.30	0.60	0.40	0.62	0.38	0.61	0.39	0.63	0.37	0.61	0.39	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.61	0.39
0.35	0.60	0.40	0.62	0.38	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.61	0.39
0.40	0.61	0.39	0.62	0.38	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.61	0.39
0.45	0.61	0.39	0.62	0.38	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.62	0.38	0.61	0.39	0.61	0.39	0.61	0.39
0.50	0.61	0.39	0.61	0.39	0.61	0.39	0.61	0.39	0.61	0.39	0.61	0.39	0.61	0.39	0.61	0.39	0.61	0.39	0.61	0.39
0.55	0.63	0.37	0.60	0.40	0.61	0.39	0.60	0.40	0.62	0.38	0.62	0.38	0.61	0.39	0.61	0.39	0.61	0.39	0.62	0.38
0.60	0.65	0.35	0.59	0.41	0.61	0.39	0.58	0.42	0.63	0.37	0.63	0.37	0.61	0.39	0.62	0.38	0.62	0.38	0.62	0.38
0.65	0.67	0.33	0.59	0.41	0.61	0.39	0.57	0.43	0.64	0.36	0.64	0.36	0.61	0.39	0.62	0.38	0.62	0.38	0.63	0.37
0.70	0.69	0.31	0.58	0.42	0.61	0.39	0.55	0.45	0.64	0.36	0.64	0.36	0.60	0.40	0.62	0.38	0.62	0.38	0.63	0.37
0.75	0.70	0.30	0.57	0.43	0.61	0.39	0.53	0.47	0.65	0.35	0.65	0.35	0.60	0.40	0.62	0.38	0.62	0.38	0.63	0.37
0.80	0.72	0.28	0.56	0.44	0.61	0.39	0.52	0.48	0.66	0.34	0.66	0.34	0.60	0.40	0.62	0.38	0.62	0.38	0.64	0.36
0.85	0.74	0.26	0.55	0.45	0.61	0.39	0.50	0.50	0.67	0.33	0.67	0.33	0.60	0.40	0.63	0.37	0.63	0.37	0.64	0.36
0.90	0.76	0.24	0.54	0.46	0.61	0.39	0.49	0.51	0.67	0.33	0.67	0.33	0.59	0.41	0.63	0.37	0.63	0.37	0.65	0.35
0.95	0.78	0.22	0.53	0.47	0.61	0.39	0.47	0.53	0.68	0.32	0.68	0.32	0.59	0.41	0.63	0.37	0.63	0.37	0.65	0.35

Although in the related literature has addressed this process, in which eco-labelling reflects the ecological awareness of society, to date no studies have been devoted to its impact on sustainable consumption. Some research has focused on the issue on the informed choices made by consumers after having been exposed to eco-labelled products (Shen, 2012), while other projects have focused more on the factors that pre-condition consumer attitudes and draw their attention to eco-labels (van Amstel et al., 2008). The considerable impact on ecological consumption revealed in recent research, is controversial and is still more complex than expected (Horne, 2009), which is why our own research has concentrated on eco-labelling from the point of view of both consumers and producers.

The major novelty presented in this article is the highlighting of the possible prerequisites that guide both producers and consumers in their product decision-making as well as to evaluate eco-labelling as a tool linking both groups.

The pro-ecological attitudes of companies are being shaped to a considerably extent by consumers who, ever more aware of ecological issues, are becoming increasingly interested in the impact a product may have upon the environment when choosing pro-ecological products. Consumers can mitigate their own impact upon the natural environment and make a difference through their purchasing decisions. It is worth noting that the growing number of consumers preferring and willing to buy organic products is creating new opportunities for companies offering such items. That is why a better understanding of consumer preferences in this area should lead to companies adopting a more market-oriented approach in order to survive and remain on a competitive market (Koos, 2011; Simeone et al., 2016). One of the undoubted benefits of purchasing organic products is that it reduces humanity's adverse impact on the environment and in this way helps us achieve the major objectives of sustainable production and sustainable consumption. However, this is dependent on increasing ecological awareness among consumers. As a consequence, ecological education is a crucial tool of communication and information and its goal should be to achieve a situation in which the consumer is consciously able to interpret eco-labels and on their basis make the right product choices. If this pre-condition is not satisfied, information overload from advertisements and marketing campaigns will lead to target group members misinterpreting messages from broadcasters. However, if they are to generate a positive effect, eco-labelling must be scientificallynormalized and consumers' ecological awareness raised.

The outcome of the present research is that: 1) it will enable managers to design product strategies in a more effective manner as a result of being able to definition target groups more precisely 2) it will help managers to plan purchases in a more effective manner, 3) it will allow customers to choose products consciously.

However, the key to success is to raise ecological awareness among consumers who can mitigate their impact upon the environment and make positive changes in their own purchasing decisions. This may be a major goal of future research on the e-commerce model, with the focus on looking at different perceptions of labels. This is a crucial topic, taking into consideration the current Covid-19 pandemic and related and noticeable changes in consumer habits. These changes should also be noticed by producers adjusting their message to the e-commerce model. The question thus arises: what should be the goals behind the development of eco-labelling?

The conclusion to be drawn from the preliminary research is that a more pro-ecological orientation can be fostered by consumers who in their purchasing decisions take into account the environmental impact of a product (Pedersen and Neergaard, 2006). To keep pace with this growing ecological awareness enterprises will be forced to minimize the environmental impact of their products in all phases of the life cycle. Environmental labeling is intended as a tool to support sustainable production and sustainable consumption, the main goal of which is to draw attention to environmentally friendly products (Mufidah et al., 2018). Boosting sales of environmentally safe products and eliminating

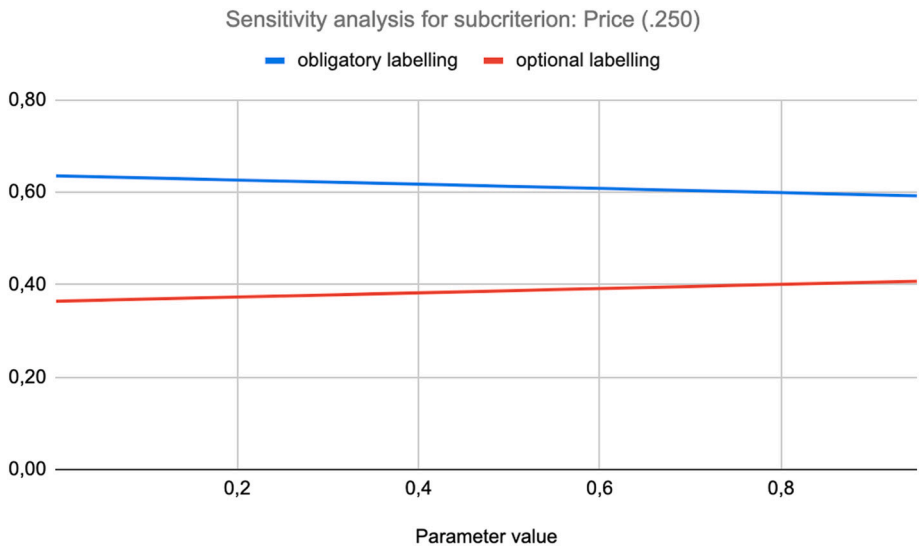

Fig. 5. Sensitivity analysis with respect to Price.

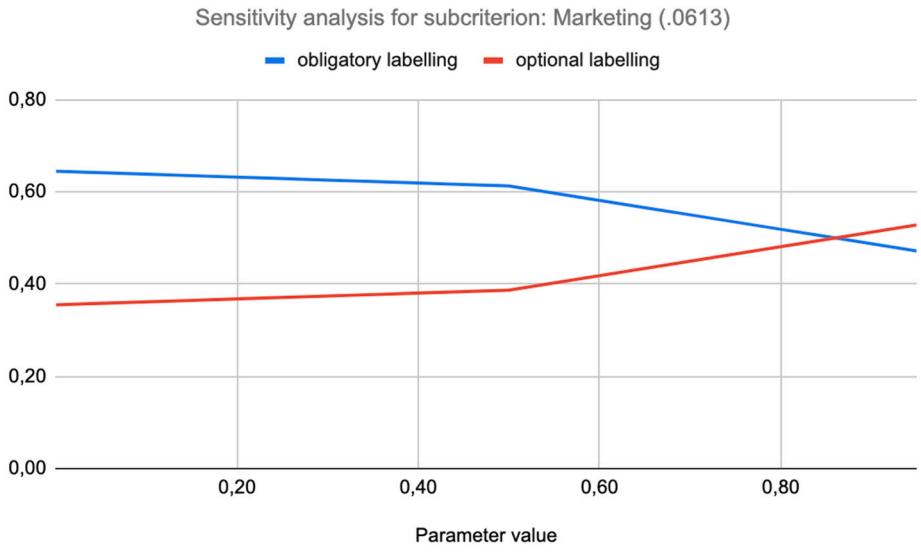

Fig. 6. Sensitivity analysis with respect to Marketing.

those whose production or use places a significant burden on the natural environment can be achieved by consumers and bidders becoming more aware of the benefits of buying environmentally friendly products (Rochikashvili and Bongaerts, 2018). The proposed strategies for improving environmental labeling, developed on the basis of the AHP method, do not exhaust all the possibilities. The limited ecological awareness of both consumers and business representatives, which is the basic barrier impeding the proper use of environmental labeling, remains a key, unsolved problem. Overcoming this barrier will require conducting educational and information campaigns aimed at society as a whole, because only then will environmental labeling be able to perform its functions effectively (S. C. Lin et al., 2017; Song et al., 2019).

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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.

References

Aczél, J., Saaty, T.L., 1983. Procedures for synthesizing ratio judgements. J. Math. Psychol. 27 (1), 93–102. https://doi.org/10.1016/0022-2496(83)90028-7.

Adekambi, Souleïmane A., Ingenbleek, Paul T.M., van Trijp, Hans C.M., 2015. Integrating producers at the base of the pyramid with global markets: a market learning approach. J. Int. Mark. 1–51. https://doi.org/10.1509/1069-0031X-23.4.44.

Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., Van Huylenbroeck, G., 2011. The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food. Br. Food J. 113 (11), 1353–1378. https://doi.org/10.1108/00070701111179988.

Alonso, J.A., Lamata, M.T., 2006. Consistency in the analytic hierarchy process: a new approach. Int. J. Uncertainty, Fuzziness Knowledge-Based Syst. 14 (04), 445–459. https://doi.org/10.1142/S0218488506004114.

Alonso, F.A., Casas, J.R., Nazar, M., 2006. Use of genetic algorithms for optimal policies of M&R in a bridge network. In: Proceedings of the 3rd International Conference on

Bridge Maintenance, Safety and Management - Bridge Maintenance. Life-Cycle Performance and Cost, Safety, Management. https://doi.org/10.1201/b18175-23.
Álvarez, I.G., 2018. Assessing corporate environmental issues in international companies: a study of explanatory factors. Bus. Strateg. Environ. 27 (8), 1284–1294. https://doi.org/10.1002/bse.2175.
Apostolou, B., Hassell, J.M., 2002. Note on consistency ratio: a reply. Math. Comput. Model. 35 (9–10), 1081–1083. https://doi.org/10.1016/S0895-7177(02)00071-7.
Bengtsson, M., 2018. Transforming systems of consumption and production for achieving the sustainable development goals: moving beyond efficiency. Sustain. Sci. 13 (6), 1533–1547. https://doi.org/10.1007/s11625-018-0582-1.
Bertrandias, L., Bernard, Y., Bertrandias, L., Bernard, Y., 2017. The environmental labelling rollout of consumer goods by public authorities: analysis of and lessons learned from the French case. J. Clean. Prod. 161, 688–697. https://doi.org/10.1016/j.jclepro.2017.05.179.
Birg, L., Voßwinkel, J.S., 2018. Minimum quality standards and compulsory labeling when environmental quality is not observable. Resour. Energy Econ. 53, 62–78. https://doi.org/10.1016/j.reseneeco.2018.01.003.
Bougherara, D., Combris, P., 2009. Eco-labelled food products: what are consumers paying for? Eur. Rev. Agric. Econ. 36 (3), 321–341. https://doi.org/10.1093/erae/jbp023.
Buelow, S., Lewis, H., 2010. The role of labels in directing consumer packaging waste. Manag. Environ. Qual. 21 (1477–7835), 198–213. https://doi.org/10.1108/14777831011025544.
Buhl, A., Schmidt-keilich, M., Muster, V., Blazejewski, S., Schrader, U., Harrach, C., Sch, M., 2019. Design thinking for sustainability: why and how design thinking can foster sustainability-oriented innovation development. J. Clean. Prod. 231, 1248–1257. https://doi.org/10.1016/j.jclepro.2019.05.259.
Bullock, G., Van Der Ven, H., 2018. The shadow of the consumer: analyzing the importance of consumers to the uptake and sophistication of ratings, certifications, and eco-labels. Organ. Environ. 1–21. https://doi.org/10.1177/1086026618803748.
Cao, S., Lv, Y., Zheng, H., Wang, X., 2014. Research of the risk factors of China ' s unsustainable socioeconomic development: lessons for other nations. Soc. Indic. Res. 229 https://doi.org/10.1007/s11205-014-0740-5.
Chinese, T., Kong, H., Kong, H., 2001. The knowledge value of customers and employees in product quality. J. Manag. Dev. 20 (8), 691–704.
Clemenz, G., 2010. Eco-labeling and horizontal product differentiation. Environ. Resour. Econ. 45 (4), 481–497. https://doi.org/10.1007/s10640-009-9324-2.
Colomer, J.M., 2013. Ramon Llull: from 'Ars electionis' to social choice theory. Soc. Choice Welf. 40 (2), 317–328. https://doi.org/10.1007/s00355-011-0598-2.
Dadkhah, K.M., Zahedi, F., 1993. A mathematical treatment of inconsistency in the analytic hierarchy process. Math. Comput. Model. 17 (4–5), 111–122. https://doi.org/10.1016/0895-7177(93)90180-7.
Di Martino, J., Nanere, M.G., Dsouza, C., 2019. The effect of pro-environmental attitudes and eco-labelling information on green purchasing decisions in Australia. J. Nonprofit Public Sector Market. 0 (0), 1–25. https://doi.org/10.1080/10495142.2019.1589621.
Dyer, R.F., Forman, E.H., 1992. Group decision support with the analytic hierarchy process. Decis. Support. Syst. 8 (2), 99–124. https://doi.org/10.1016/0167-9236(92)90003-8.
Eisenmenger, N., Pichler, M., Krenmayr, N., Noll, D., Plank, B., Schalmann, E., Theres, M., Simone, W., 2020. The sustainable development goals prioritize economic growth over sustainable resource use: a critical reflection on the SDGs from a socio _ ecological perspective. Sustain. Sci. Sachs 2012. https://doi.org/10.1007/s11625-020-00813-x.
Fan, T., Song, Y., Cao, H., Xia, H., 2019. Optimal eco-labeling strategy with imperfectly informed consumers. Ind. Manag. Data Syst. 1166–1188 (6), 1166–1188. https://doi.org/10.1108/IMDS-06-2018-0256.
Fernandes, V., Limont, M., Bonino, W., 2020. Sustainable development assessment from a capitals perspective: analytical structure and indicator selection criteria. J. Environ. Manag. 260 (January), 110147. https://doi.org/10.1016/j.jenvman.2020.110147.
Forman, E., Peniwati, K., 1998. Aggregating individual judgments and priorities with the analytic hierarchy process. Eur. J. Oper. Res. 108 (1), 165–169. https://doi.org/10.1016/S0377-2217(97)00244-0.
Gallastegui, I.G., 2002. The Use of Eco-Labels: A, 331, pp. 316–331. https://doi.org/10.1002/eet.304.
Golden, B.L., Wang, Q., 1989. An alternate measure of consistency. In The Analytic Hierarchy Process. https://doi.org/10.1007/978-3-642-50244-6_5.
Gong, D., Kao, C., Peters, B.A., 2019. Sustainability investments and production planning decisions based on environmental management. J. Clean. Prod. 225, 196–208. https://doi.org/10.1016/j.jclepro.2019.03.256.
Gutierrez, A.M.J., Chiu, A.S.F., Seva, R., 2020. A proposed framework on the affective design of eco-product labels. Sustainability (Switzerland) 12 (8). https://doi.org/10.3390/SU12083234.
Haldar, S., 2019. Towards a conceptual understanding of sustainability - driven entrepreneurship. Corp. Soc. Responsib. Environ. Manag. 26 (6), 1157–1170. https://doi.org/10.1002/csr.1763.
Hazarika, N., Zhang, X., 2019. Evolving theories of eco-innovation: a systematic review. Sustain. Prod. Consum. 15 (xxxx), 1–15. https://doi.org/10.1016/j.spc.2019.03.002.
Hoque, N., 2014. Analysing sustainable consumption patterns: a literature review. Development 56 (3), 370–377. https://doi.org/10.1057/dev.2014.13.
Horne, R.E., 2009. Limits to labels: the role of eco-labels in the assessment of product sustainability and routes to sustainable consumption. Int. J. Consum. Stud. 33 (2), 175–182. https://doi.org/10.1111/j.1470-6431.2009.00752.x.
Jose, C., Jabbour, C., Seuring, S., Beatriz, A., De Sousa, L., Jugend, D., De Camargo, P., Latan, H., Colucci, W., 2020. Stakeholders, innovative business models for the circular economy and sustainable performance of firms in an emerging economy facing institutional voids. J. Environ. Manag. 264 (November 2019), 110416. https://doi.org/10.1016/j.jenvman.2020.110416.
Joshi, Y., Rahman, Z., 2015. Factors affecting green purchase behaviour and future research directions. In: International Strategic Management Review, Vol. 3. Holy Spirit University of Kaslik. https://doi.org/10.1016/j.ism.2015.04.001 issues 1–2.
Koos, S., 2011. Varieties of environmental labelling, market structures, and sustainable consumption across europe: a comparative analysis of organizational and market supply determinants of environmental-labelled goods. J. Consum. Policy 34 (1), 127–151. https://doi.org/10.1007/s10603-010-9153-2.
Kułakowski, K., 2016. Notes on the existence of a solution in the pairwise comparisons method using the heuristic rating estimation approach. Ann. Math. Artif. Intell. https://doi.org/10.1007/s10472-015-9474-6.
Kułakowski, K., Szybowski, J., Prusak, A., 2019. Towards quantification of incompleteness in the pairwise comparisons methods. Int. J. Approx. Reason. 115, 221–234. https://doi.org/10.1016/j.ijar.2019.10.002.
Kusch-brandt, S., 2019. Sigrid Kusch-brandt department of civil, environmental and architectural engineering, University of Padua, Padua, Italy. Encyclopedia of the UN Sustainable Development Goals. https://doi.org/10.1007/978-3-319-71062-4_10-2.
Lane, E.F., Verdini, W.A., 2007. A consistency test for AHP decision makers. Decision Sciences 20 (3), 575–590. https://doi.org/10.1111/j.1540-5915.1989.tb01568.x.
Laruccia, M.M., Garcia, M.G., 2015. An analysis of the perception and use of ecodesign practices by companies. Brazilian Business Review 12 (3), 1–15. https://doi.org/10.15728/bbr.2015.12.3.1.
Les Carlson, S.J.G., N. K., 1993. A content analysis of environmental advertising claims: a matrix method approach. J. Advert. 22 (3), 27–39. https://doi.org/10.1080/00913367.1993.10673409.
Lin, S., Lin, A., San, B., North, A., Antonio, S., 1945. Understanding the Consumers ' Perspective in Accepting the Ecolabel Product by a Structural Reasoned Model Assessment.
Lin, S.C., Nadlifatin, R., Amna, A.R., Persada, S.F., Razif, M., 2017. Investigating citizen behavior intention on mandatory and voluntary pro-environmental programs through a pro-environmental planned behavior model. Sustainability (Switzerland) 9 (7). https://doi.org/10.3390/su9071289.
Loureiro, M.L., Mccluskey, J.J., Mittelhammer, R.O.N.C., 2002. Will consumers pay a premium for eco-labeled apples ?, 36 (2), 203–219.
Lyon, T.P., Montgomery, A.W., 2015. The means and end of greenwash. Organ. Environ. 28 (2), 223–249. https://doi.org/10.1177/1086026615575332.
Malik, N., Kumar, P., Shrivastava, S., 2016. An overview on PET waste recycling for application in packaging. Int. J. Plast. Technol. https://doi.org/10.1007/s12588-016-9164-1.
Meissner, F., Haas, A., Bisaro, A., 2020. A typology for analysing mitigation and adaptation win-win strategies. Clim. Chang. 1 https://doi.org/10.1007/s10584-020-02681-x.
Mufidah, I., Jiang, B.C., Lin, S.C., Chin, J., Rachmaniati, Y.P., Persada, S.F., 2018. Understanding the consumers' behavior intention in using green ecolabel product through pro-environmental planned behavior model in developing and developed regions: lessons learned from Taiwan and Indonesia. Sustainability (Switzerland) 10 (5), 1–15. https://doi.org/10.3390/su10051423.
Murali, K., Lim, M.K., Petruzzi, N.C., 2018. Manufacturing & service operations management the effects of ecolabels and environmental regulation on green product development the effects of ecolabels and environmental regulation on green product development. Manuf. Serv. Oper. Manag. 21 (3), 479–711.
Network, G.E., Paper, I., July, P., 2004. Global Ecolabelling Network (Gen) Information Paper: Introduction to Ecolabelling Prepared July 2004 Introduction to Ecolabelling. July.
Nikolaou, I.E., Tsalis, T.A., Evangelinos, K.I., 2018. A framework to measure corporate sustainability performance: a strong sustainability-based view of firm. Sustain. Prod. Consum. 18 (xxxx), 1–18. https://doi.org/10.1016/j.spc.2018.10.004.
Nilsson, O.S., Nissen, N.P., Thøgersen, J., Vilby, K., 1999. Rapport Fra 'Forbrugergruppen' under Erhvervsministeriets Mærkningsudvalg.
Pedersen, E.R., Neergaard, P., 2006. Caveat emptor – let the buyer beware! Environmental labelling and the limitations of 'green' consumerism. Bus. Strateg. Environ. 29 (August 2005), 15–29.
Pigosso, D.C.A., Mcaloone, T.C., Pigosso, D.C.A., Mcaloone, T.C., 2017. Measuring the implementation of ecodesign management practices: a review and consolidation of process-oriented performance indicators. J. Clean. Prod. 156, 293–309. https://doi.org/10.1016/j.jclepro.2017.04.049.
Rochikashvili, M., Bongaerts, J.C., 2018. How eco-labelling influences environmentally conscious consumption of construction products. Sustainability (Switzerland) 10 (2). https://doi.org/10.3390/su10020351.
Saari, D.G., 2009. Condorcet domains: a geometric perspective. In: The Mathematics of Preference, Choice and Order. https://doi.org/10.1007/978-3-540-79128-7_9.
Saaty, Thomas L., 1980. The analytic hierarchy process: planning. In: Priority Setting. Resource Allocation. New York International Book Company, MacGraw-Hill.
Saaty, T.L., 2002. Decision making with the analytic hierarchy process. Sci. Iranica. https://doi.org/10.1504/ijssci.2008.017590.
Saaty, T.L., 2008. Relative measurement and its generalization in decision making. In: Revista de La Real Academia de Ciencias Exactas, Físicas y Naturales. Serie A: Matemáticas (RACSAM)..
Saaty, Thomas L., Vargas, L.G., 1985. Modeling behavior in competition: the analytic hierarchy process. Appl. Math. Comput. https://doi.org/10.1016/0096-3003(85)90009-8.

Sammer, K., Wüstenhagen, R., 2006. The influence of eco-labelling on consumer behaviour - results of a discrete choice analysis for washing machines. Bus. Strateg. Environ. 15 (3), 185–199. https://doi.org/10.1002/bse.522.

Schaubroeck, S., Schaubroeck, T., Baustert, P., Gibon, T., Benetto, E., 2020. When to replace a product to decrease environmental impact ? — a consequential LCA framework and case study on car replacement. Int. J. Life Cycle Assess. 25, 1500–1521 doi:10.1007@s11367-020-01758-0.

Schumacher, I., 2010. Ecolabeling, consumers' preferences and taxation. Ecol. Econ. 69 (11), 2202–2212. https://doi.org/10.1016/j.ecolecon.2010.06.005.

Sebestyén, V., Domokos, E., Abonyi, J., 2020. Focal points for sustainable development strategies — text mining-based comparative analysis of voluntary national reviews. J. Environ. Manag. 263, 110414. https://doi.org/10.1016/j.jenvman.2020.110414.

Shen, J., 2012. Understanding the determinants of Consumers' willingness to pay for eco-labeled products: an empirical analysis of the China environmental label. J. Serv. Sci. Manag. 05 (01), 87–94. https://doi.org/10.4236/jssm.2012.51011.

Simeone, M., Scarpato, D., Marinelli, N., 2016. Factors affecting food label complexity: does the new EU regulation satisfy consumer issues ? An exploratory study factors affecting food label complexity: does the new EU regulation satisfy consumer issues ? An exploratory study. J. Food Prod. Mark. 22 (5), 571–583. https://doi.org/10.1080/10454446.2015.1121422.

Smith, S., Paladino, A., 2010. Eating clean and green? Investigating consumer motivations towards the purchase of organic food. Australas. Mark. J. 18 (2), 93–104. https://doi.org/10.1016/j.ausmj.2010.01.001.

Song, Y., Qin, Z., Yuan, Q., 2019. The impact of eco-label on the young Chinese generation: the mediation role of environmental awareness and product attributes in green purchase. Sustainability (Switzerland) 11 (4). https://doi.org/10.3390/su11040973.

Stanev, V., 2017. Advertising in the age of hyper consumption. Trakia J. Sci. 15, 186–190. Doi:10.15547/tjs.2017.s.01.034.

Steele, K., Carmel, Y., Cross, J., Wilcox, C., 2009. Uses and misuses of multicriteria decision analysis (MCDA) in environmental decision making. Risk Anal. 29 (1), 26–33. https://doi.org/10.1111/j.1539-6924.2008.01130.x.

Stein, W.E., Mizzi, P.J., 2007. The harmonic consistency index for the analytic hierarchy process. Eur. J. Oper. Res. 177 (1), 488–497. https://doi.org/10.1016/j.ejor.2005.10.057.

Tatić, Kasim, Haraci, Mahir, Haračić, M., 2018. The improvement of business efficiency through business process management. Econ. Rev. XVI (1), 31–43.

Taufique, K.R., Siwar, C., Talib, B., Sarah, F.H., Chamhuri, N., 2014. Synthesis of constructs for modeling consumers' understanding and perception of eco-labels. Sustainability 6, 2176–2200. https://doi.org/10.3390/su6042176.

Tunn, V.S.C., Bocken, N.M.P., Van Den Hende, E.A., Schoormans, J.P.L., 2018. Business models for sustainable consumption in the circular economy: an expert study. J. Clean. Prod. https://doi.org/10.1016/j.jclepro.2018.11.290.

van Amstel, M., Driessen, P., Glasbergen, P., 2008. Eco-labeling and information asymmetry: a comparison of five eco-labels in the Netherlands. J. Clean. Prod. 16 (3), 263–276. https://doi.org/10.1016/j.jclepro.2006.07.039.

Van Der Werf, H.M.G., Salou, T., 2015. Economic value as a functional unit for environmental labelling of food and other consumer products. J. Clean. Prod., November 2013 2013–2016. https://doi.org/10.1016/j.jclepro.2015.01.077.

Wang, L., Cui, Z., Liang, X., 2015. Does it pay to be green? Financial benefits of environmental labeling among Chinese firms, 2000–2005. Manag. Organ. Rev. 11 (3), 493–519. https://doi.org/10.1017/mor.2014.8.

Wątróbski, J., Jankowski, J., Ziemba, P., Karczmarczyk, A., Zioło, M., 2019. Generalised framework for multi-criteria method selection. Omega 86, 107–124. https://doi.org/10.1016/j.omega.2018.07.004.

Wu, K., Lang, M., Lim, M.K., Sf, A., 2019. Causal sustainable resource management model using a hierarchical structure and linguistic preferences. J. Clean. Prod. 229, 640–651. https://doi.org/10.1016/j.jclepro.2019.04.394.

Yau, Y., 2012. Eco-labels and willingness-to-pay: a Hong Kong study. Smart Sustain. Built Environ. 1 (3), 277–290. https://doi.org/10.1108/20466091211287146.