Green product development – customers and producers reflection

MATJAŽ MALETIČ, DAMJAN MALETIČ, BOŠTJAN GOMIŠČEK

Abstract**—**This paper intends to provide a better understanding of environmentally friendly design concerning various aspects, including customers' and producers' perspectives. The results of the research study conducted in Slovenia provide an important link between customers and producers view considering green products. The customers appear to recognize the importance of environmental concerns regarding green product development, even though their main purchase-decision criteria are: their needs, quality and price. This applies that in order for green product to succeed, product characteristics should be in a balance with quality (and consequently customer's need) and environmental protection. The results also highlight the different views according to the benefits of green products. From customers' point of view, the most important benefits for producers regarding green products is enhanced reputation (response rate was 33%), while producers believe that customer trust is the most important benefit obtained from green products (response rate was 31%). However, it seems that there is still often too little awareness and understanding of the wider environmental, social and economic impacts of green product design.

Keywords**—**green product development, ecodesign, green customer, producer, environmentally friendly product

I. INTRODUCTION

To gain deeper and more comprehensive understandings of the significance of sustainability for product design, it is essential to consider the views of those who acquire and use products, and those who are responsible for integration of sustainability issues into product design. Moving towards sustainable development has became a major concern in most of the developed countries, resulting in stricter regulations concerning the impact of the products during their manufacturing, use and end of life, including the obligation to define reverse logistics strategies and systems [32]-[38]-[48]. Business is probably best placed to respond positively to sustainability challenges via radical innovative products and services and related new business models. Their drive for efficiency gives them a natural role in making production and products more resource efficient [14]. Generally, the goal of reducing environmental pressure by consumption can be reached via three routes: greening production and products, shifting demand to low-impact consumption categories, and lowering material demands [36]-[96]-[97]-[98]. While sustainable consumption targets consumers, sustainable production is related to companies and organizations that make products or offer services [100].

As Cooper [15] indicates, sustainable consumption involves rethinking how products are conceived and how needs are met. In other words, it requires that we not only address efficiency (i.e. 'getting the same goods and services out of less'), but also sufficiency, (i.e. 'getting the same welfare out of fewer goods and services') [12]. Accordingly, traditional product-centered approaches alone are not capable of providing sufficient change. Highly creative, informed and sensitive design interventions are necessary for the development of alternative solutions that are ecologically responsible, socially relevant, aesthetically pleasing, economically viable, technologically appropriate, and individually satisfying [57]. As stated by Amacher et al. [1], customer preference to purchase from ''green'' organizations is well established and often revealed through increased willingness to pay for products viewed as ''clean,'' i.e., produced with environmentally friendly production or abatement technologies such as recycling and use of less polluting inputs. However, an individual concerned about the environment does not necessarily behave in a green way in general, or in their purchasing [73]. This is known as the value-action gap.

From the corporate point of view, the environmental protection is a vital management function, it is perceived as being instrumental in the development of a positive corporate image and an important element to the success of a business enterprise [23]. However, environmental management is not, as the phrase could suggest, the management of the environment as such, but rather the management of interaction by the modern human societies with, and impact upon the environment [15].

Environmentally conscious design (eco-design) is particularly important in manufacturing industry, and many design methods and tools have been developed to support eco-design [47]. Although there are several different ways to define ecodesign [40], ecodesign may be defined as an activity that identifies the environmental aspects of a product and integrates them into the product design process in the early stage of the product development process [70]. Therefore, ecodesign approach is mainly focused on the environmental aspects of a

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product. It has been noted that a product must meet the basic requirements of a market. These requirements include the following: (1) meeting the required needs in terms of function, performance, durability, safety, etc.; (2) complying with all standards and regulations; and (3) corresponding to the targeted market segments, such as identifying current and emerging customer expectations [70]. If a product does not meet these basic requirements, then the product will fail in the marketplace even if it causes less stress on the environment [48]. Functionality of the product and profit to the company are examples of two aspects, which always have very high priority, higher than environmental demands [55]. Without customers buying a product and companies making profit there will be no market, no matter the environmental issue.

It is clear that organizations have to deal with complex issues, which are related to different aspects of product development. From designers' point of view, the development of more environmentally-friendly products brings them to take into consideration environmental aspects in concurrence with traditional technical and economical aspects since the beginning of design activities [26]. The requisites an industrial product has to be in compliance with, have become more numerous and stricter than in the past, involving also social aspects, i.e. the impact that industrial products have on the society in general, considering for example their performances from the safety and the environmental point of view [25].

The design steps, then, become critical as a mean of optimising the lifecycle performance, increasing the profitability, enhancing the delivery quality, responding to the regulatory drivers, satisfying customers, stakeholders and third parties, up to facing the manufacturers' responsibility for the whole supply chain [63].

In the present highly competitive context, designing products which are more respectful for the environment makes sense if the head of the company has strong environmental convictions or more often if the company can get an advantage from this engagement [39]. This involvement can be paid back in terms of image [87], but also in terms of market share: it is now clear that environmental regulations can result in barriers against low cost countries [31], but may also bring a competitive advantage, in a context of increased customer awareness on environmental issues [58]-[92]-[93].

This paper aims, therefore, at providing insights into product design considering environmental aspects as well as customers' point of view with regard to the environmentally friendly products. The purpose is to investigate the customer's and producer's point of view in relation to environmentally friendly products.

II. RELATED LITERATURE

A. The context of ecodesign and sustainability

Since environmental impacts are intimately connected to flows of materials and energy, and the most important flows, at least for manufacturing companies, are closely linked to products [6] it seems very important to consider environmental aspects during the product development [68]. Increasing the product durability, extending its useful life through upgrading or remanufacturing, and the possibility of recycling represent some tools in hands of designers performing a design for environment; these are also the main ways to reduce the waste [5].

In recent years, there has been an increasing emphasis on the concept of 'win-win' environmental strategies, whereby environmental product benefits go hand-in-hand with technical and economic cost-effectiveness [79]. This is intuitively appealing, since products whose production and use entail less energy, less material input and less waste and pollution should be cost-effective for both consumer and producer. In practice, however, developing a product which excels in environmental terms while remaining economically and technically competitive, is a significant challenge [79].

During the last decade a substantial amount of research has been addressed to ecodesign (environmentally conscious design), which refers to actions taken in product development aimed at minimising a product's environmental impact during its whole life cycle (ISO/TR 14062:2002), without compromising other essential product criteria such as performance and cost [42]. It should be remembered that eco-design only adds environmental considerations to product design, it stops short of full sustainable design [46]. Such an approach would incorporate more innovative practices, employ ecological principles, and encompass social and ethical aspects [94]. Byggeth et al. [11] suggested a method for sustainable product development (MSPD) with the aim of integrating social and ecological aspects of sustainability with a strategic business perspective in product development. They propose a modular system where questions concerning sustainability aspects are organised into a system of sustainability product assessment modules. The main reason of proposed modular system is to facilitate the use of the MSPD and give the user the possibility to decide which sustainability aspect should be used and when. A method for sustainable product development should be integrated with the product development process (PDP) to be successful in a company [10]-[27]. It is suggested that the early part of the product innovation process is a critical intervention point for the transformation of society toward sustainability [68]. Nevertheless, organizations need performance indicators in order to determine if objectives are being pursued and whether the broader goals of sustainable development are being achieved. For example, Hrebicek et al. [37] proposed several quantifiable metrics that reflect the EP of a business in the context of achieving its wider goals and objectives. These KPIs can help businesses to implement strategies by linking various levels of an organisation (business units, departments and individuals) with clearly defined targets and benchmarks of selected economic activities.

According to Stevels [90], ecodesign seeks to understand the life cycle of the product and its impact on the environment at each of its life-cycle stages and to make better decisions during product design so that environmental attributes of the product are kept at desired level. The reason for incorporating ecodesign depends on the strategy for each company. Some companies are defensive, proactive or cost driven in their

reactions to external development related to environment (i.e., social pressures, additional legislation or taxes) [83]. Eco-efficiency can lead to cost reduction, strengthen the market position of existing products, extended products to new markets, advert criticism by external stakeholders, and increase the possibility of company's surviving in the long run [18]. With respect to the eco-efficiency, Popa and Dănilă [75] proposed an eco-friendly electronics products/processes environmental impact matrix in order to evaluate and reduce toxicity of electronic product. Rose [83] suggested that the ecodesign give companies opportunities such as: satisfying customer, strengthening corporate competitiveness, and complying legislation.

Studies show that factors which influence a firm's decision to undertake eco-design are various and may be divided into drivers that are external and internal to the organization [31]. Legislation and customer demand have been cited as the most important external drivers of eco-design [4]-[99]. The importance of legislation as a stimulus for eco-design is supported by evidence that changes in product design have been induced by producer responsibility in the packaging, automobile and electrical and electronic equipment (EEE) sectors [54]-[95]-[103].

B. The link between quality characteristics, customers and environmental protection

The term product can be defined as a set of tangible and intangible attributes that provides customer benefits through form and function [28]. Successful new product development requires in-depth understanding of the customers, their situation, their needs and their wants [45]-[49]. To maintain customer satisfaction and thereby long-run profitability, it is clear that companies should provide products of high quality [89].

Green product attributes may be environmentally sound production processes, responsible product uses, or product elimination, which customers compare with those possessed by competing conventional products [62]-[72]. However, the literature does not yet offer an objective definition of what makes a product "environmentally friendly". Fuller [28] defines sustainable products as a form and function alternatives that possess positive ecological attributes that are nothing more than enhanced waste management factors (eco-attributes) that have purposely been embedded through decisions concerning how products are made/manufactured, what they are made of, how they function, how long they last, how they are distributed, how they are used, and how they are disposed of at the end of useful service life.

In the current business environment, organizations strive towards exceeding the customer's expectations. As a match between product features and customer expectations and needs, quality of design is a market, or externally oriented aspect of quality [62]. According to Widrick et al. [102], quality of design is determined by three factors: a deep understanding of customer requirements, translation of these requirements into a product and continuous improvement of the design process. Such an improvement is based on close cooperation among marketing, research and development, and engineering [62]. Quality, therefore, can be defined as satisfying or exceeding customer requirements and expectations and hence, to some extent, it is the customer who ultimately judges the quality of a product [89]. In this paper any feature or characteristic of a product that is needed to satisfy customer needs is considered as a quality characteristic.

In recent decades, the term quality has expanded beyond the classical interpretation of "satisfying customer expectations related to the supplied product" to include not only the delivery of excellence to a variety of stakeholders, but also the environmental, safety, financial, and even social aspects of organizational performance [9].

For environmentally orientated products to succeed, they will need to be effective in terms of their marketplace performance. The most advanced environmental technologies will not contribute to the pursuit of sustainability unless they can wrestle market share away from conventional products and change the market's agenda for product development and marketing [77]. In fact, companies are required to decrease environmental impacts caused by their products/services while they compete in their markets [42]-[85]. To do so, designers/developers play a crucial role; the environmental impacts are determined mainly by design. With respect to customer demands, Dalhammar [20] emphasizes the increasing importance of market drivers, although this may not be entirely independent of environmental legislation which places controls on the use of particular substances or components [31]. However, it is important to listen to customer requirements to obtain market needs and make them reflect on the product design [42].

Park and Tahara [70] suggest that environmental aspects have to be considered together with other product requirements, such as function, performance, economics, and consumer satisfaction in order for eco-products to be successful. By doing this, it is possible to develop a product that possesses a higher product value and less environmental impact – in other words, a product that has a higher eco-efficiency value. Eco-efficiency, which is defined as the ratio of the value of a product to its environmental influence [100], can be used as an analytical tool in ecodesign because eco-efficiency can help create value for a product and the company as a whole by explicitly promoting change towards sustainable growth [91].

Several authors [59]-[25]-[26]-[47] proposed integrated use of the ecodesign tools in relation to quality tools as an effective approach to support effective integration of environmental aspects into product design.

The link between quality management and environmental responsibility is also partially covered by corporate social responsibility (CSR) literature, mainly due to exploring the relationship and potential synergies between quality management and CSR [15]-[29]-[35]-[60]-[82].

III. RESEARCH RESULTS

A. Research methodology

First survey questionnaire was designed, exploring issues relating to customers' attitudes towards green products and to environmental issues concerning the producers in the Slovenia.

For the concurrent research study, data were obtained using a second survey among Slovenian producers. The sample covered a range of industries including automobiles, chemicals, plastics, IT, food and drink, paper, packaging, and some other industries and services.

The purpose of this survey was to examine producer's point of view on the integration of environmental issues in their business and into new product development process.

B. The results of the customer survey

Responses to the question on what the customers would give emphasis in product development are presented in Fig. 1. The results on the open question show that customers are aware of the importance of consideration of environmental aspects during the product design.

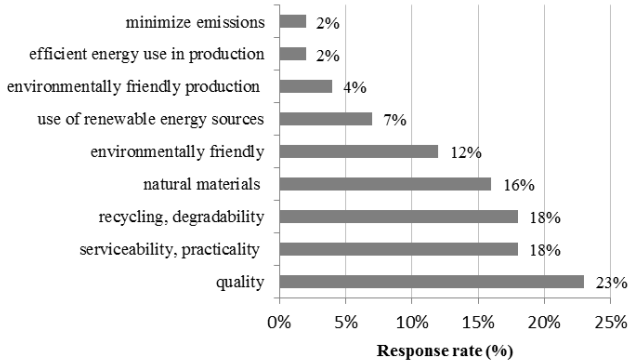

Fig. 1 Focus on product development from the customer's point of view

Quality, usability and practicality seem to be the most important factors from the customer's point of view. All the other answers indicate a positive attitude of respondents to the environment as they include only characteristics that are related to environmental protection.

The following question (Fig. 2) also reveals a positive attitude towards environment, since the vast majority identified the importance of environmental protection in product development as very important.

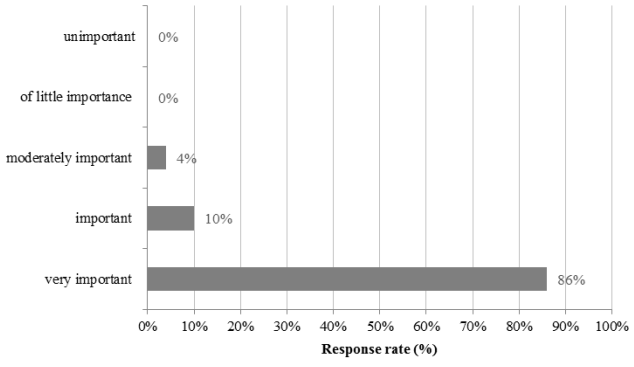

Fig. 2 The importance of integrating of environmental protection in product development

Furthermore, the respondents ranked the five given criteria by importance in the following order: the possibility of recycling, energy consumption in use, the environmental impact at the end use of product, the use of environmentally friendly materials and environmentally friendly manufacturing process.

The criteria that most affect the purchase of a product are shown in Fig. 3. Results indicate that customer's need is the most important criteria, following the product quality, price and environmental friendliness as the fourth criterion. The results presented in Fig 3 are consistent with the results in Fig. 1, where the quality and usability were also ranked ahead of factors which are related to environmental protection.

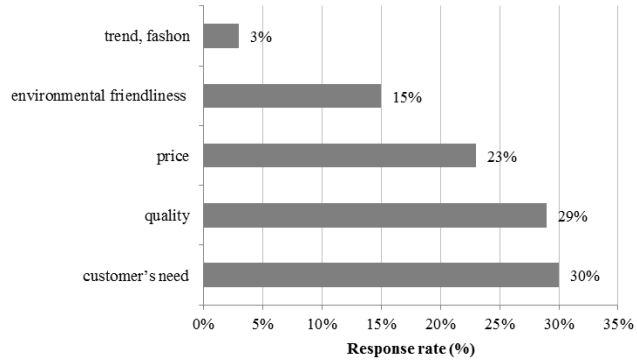

Fig. 3 Purchase-decision criteria

Based on the result, it has been shown that 72% of respondents would choose the product that is more eco-friendly (Fig. 4).

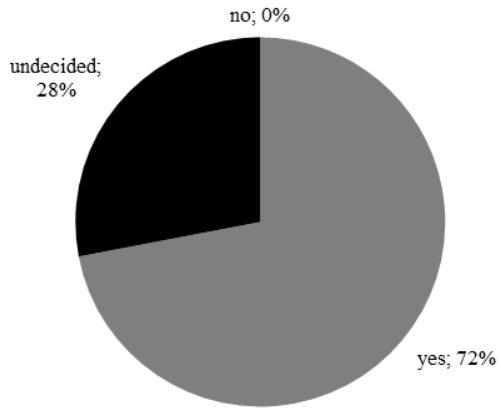

Fig. 4 Considering two similar products, would you decide to buy the product that is more environmentally friendly?

Further results are encouraging as well, since 54 percent of respondents expressed a positive purchase intention to buy a environmentally friendly product in spite of a higher price, while only 10% said that they would not buy more expensive product regardless the environmentally friendliness of a product (Fig. 5).

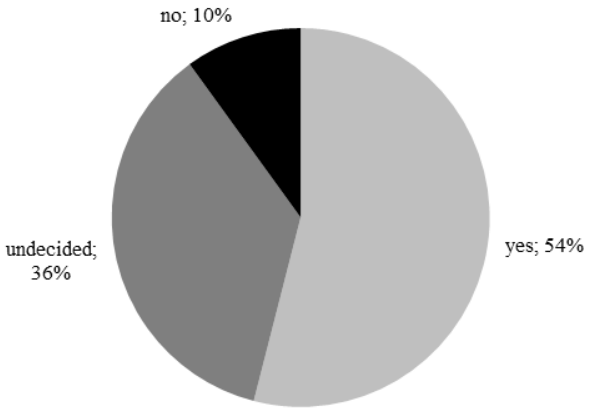

Fig. 5 Would you decide to buy a product that is more environmentally friendly in spite of a higher price?

Fig. 6 shows the responses that reflect the opinion of the customers on the question: "What do you think companies can gain with products that are friendly to the environment?" As would be expected from responses, enhanced reputation is the most important acqusition, followed by customer trust. The third most common response was reflected in the believe that this approach leads to higher costs. Sales improvement was also frequently highlighted by potential customers.

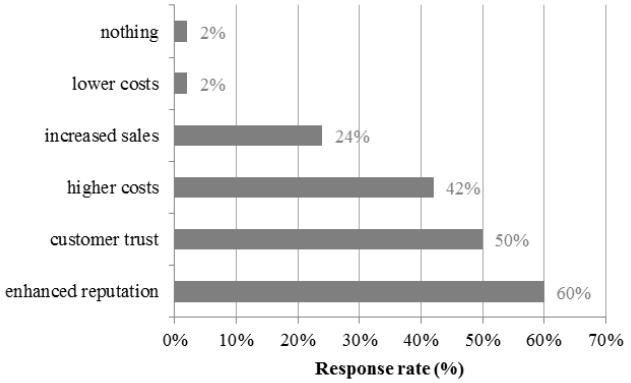

Fig. 6 What do you think companies can gain with products that are friendly to the environment?

The following open question was stated as: “Do you agree or disagree with the statement that with buying a product you may indirectly influence the environmental protection. The vast majority (97%) of respondents agreed with this statement. The reasons why they agree with this statement are as follows:

- be able to show that we buy environmentally friendly products;
- less pollution,
- purchasing such a product will increase the production of green product;
- consumer logic – offer follows demand;
- depends on what you buy and for what purpose you use the purchased;
- offer is adjusted to demand.

The remaining percentage of respondents disagree with the statement. The reasons for this are as follows:

- irregular collection of waste (recycling);
- perhaps at the local level, which is not reflected globally.

C. The results of the producer survey

The results related to the surveyed organizations will be presented in the following section.

The survey covers small (7%), medium-sized (23%) and large (70%) organizations and it provides evidence on producers’ activities towards environmental issues.

From the results in the Fig. 7 it can be seen that ISO 14001 prevails among the EMS standards (52%), following EMAS by 3%.

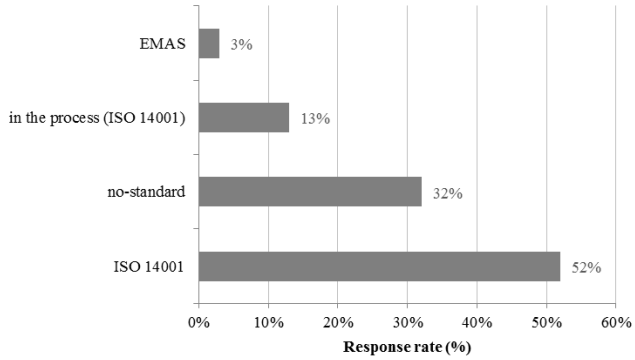

Fig.7 Standards related to environmental management systems

We were interested to examine to what extent proposed criteria (Fig. 8) influenced the decision to introduce EMS standards.

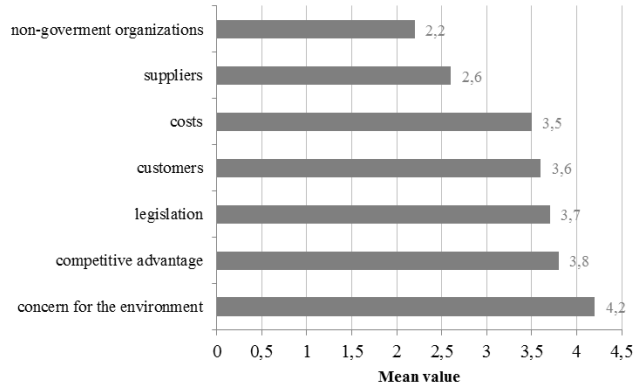

Fig. 8 Reasons for considering the environmental management system standard

According to the results, concern for the environment is the most important reason that encourages organizations to introduce EMS standard, followed by competitive advantage, legislation, customers, costs, suppliers, and non-government organizations, which influence the least.

Fig. 9 shows the results of the question: "Do you agree or disagree with the statement that the introduction of environmental standards is the only way in which a company can contribute to the environmental protection?". The reasons why 40% of respondents expressed the agreement with the statement are as follows:

- it provides systematic way of work;
- it is considered as a tool that support environmental concern;
- specific guidelines, regulations and constant verification of the status quo can force manufacturers to act;
- it cannot be affirmed that is the only way but it is certainly necessary.

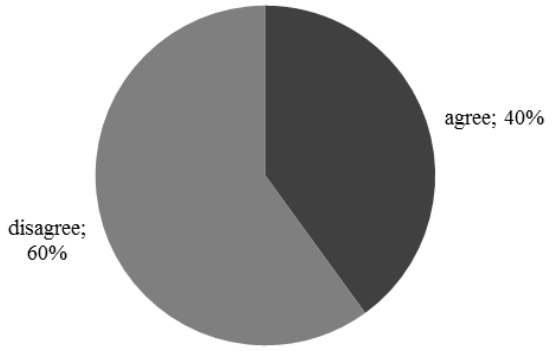

Fig. 9 Do you agree or disagree with the statement that the introduction of environmental standards is the only way in which a company can contribute to the environmental protection?

The remaining 60% of respondents believe that the introduction of EMS standards is not the only way by which a company can contribute to the environmental protection, because they believe that:

- there are also other tools (programs, strategies, legislation) and the methods by which the company can contribute to the environmental protection;
- a standard by itself does not mean a guarantee or contribution to the environmental protection, but rather it is the strict compliance with legislation that can contribute;
- there are also different approaches to environmental protection (e.g. different types of award, creative workshops for children in order to spread and rise the awareness about environment protection);
- standard is just a tool and does not provide assurance for effective environmental protection;
- standard is not a way but only a tool that support environmental protection activities;
- it is an important way of environmental protection but not the only one;
- we must realize that everyone is responsible for contributing to environmental protection;
- systematic education of employees and citizens has a greater impact on environmental protection;
- in addition to the standard, it is necessary to establish a stimulating environment (subsidies, incentives, facilities) for investments in this context/framework;
- environmental concern can be implemented/performed in many different areas and in different ways;
- there are also other ways, such as compliance with legislation, commitment to continuous improvement supported by appropriate policies and strategies;
- depends on awarerness;
- it is important to establish processes, considering feasibility;
- promoting environmental consciousness among employees;
- the EMS standard is merely the result of awareness and organization;

As far as negative effects of EMS standards are concerned, 32% of respondents expressed that introduction of EMS standard leads to more paperwork (Fig. 10). Interestingly, 26% of respondents didn't perceive any negative effects regarding the introduction of the EMS standard. As can be seen in Fig. 10, the higher costs (16%) seems to be the third common answer of respondents.

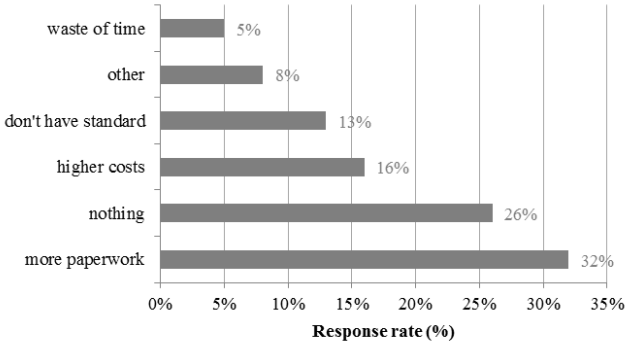

Fig. 10 Negative effects of EMS standards

Despite the fact that 40% of the surveyed organizations have not yet implemented an EMS standard, already 60% of organizations have previous experience with the introduction of environmental standards. 77% of organizations produce environmentally friendly products, 23% do not.

The results show that 60% of respondents have developed a procedure for environmentally friendly product design (ecodesign), which is the same proportion of those who already have experience with the introduction of the environmental management standards. 30% of surveyed organizations have not yet developed an ecodesign procedure, while 10% of respondents expressed that the procedure is in preparation. Among the organizations that developed an ecodesign procedure, only a smaller proportion (50%) also use the procedure, while 17% of organizations use the procedure partly and 33% of organizations do not use the procedure at all.

Among the reasons to introduce the ecodesign concept into product development process the concern for the environment

seems to be the most important criterion (25%), following by better image (18%), competitive advantage (16%) and other expressed reasons (Fig. 11).

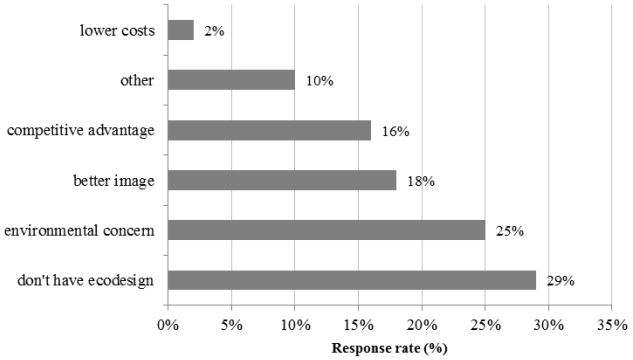

Fig. 11 Reason for introducing the ecodesign

The research among Slovenian producers showed that the research and development department (R&D) is considered as essential in environmentally friendly products development, as shown in Fig. 12. As presented by results, the quality department is also highly ranked (19%), followed by the manufacturing department (18%), marketing department (13%) and top management (10%). According to the results, customers are not significantly involved in eco-product development. There are also several other people involved in eco-product development/planning, such as ecologists (2%) and suppliers (2%).

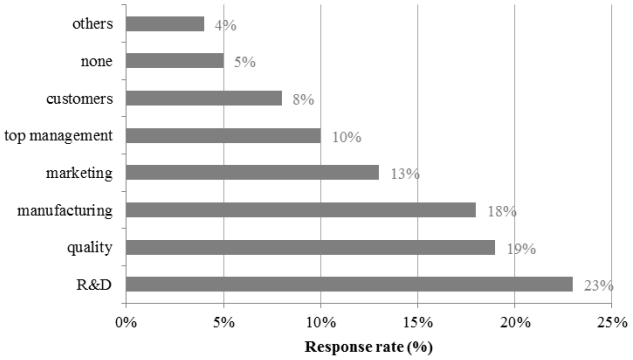

Fig. 12 Participation in environmentally friendly products development (ecodesign)

Furthermore, responsibility and participation in the planning and development of environmentally friendly products is not equally distributed between individual departments within the company. This is shown in Fig. 13, indicating that the major responsibility for planning remains for R&D department (31%) or the Head of it, followed by top management (27%), since the leadership bears full responsibility for business operations. The third place belongs to the marketing department (13%) which is consistent with the Fig. 12, followed by manufacturing department (11%) and quality department (10%). Customers were stated as others (3%).

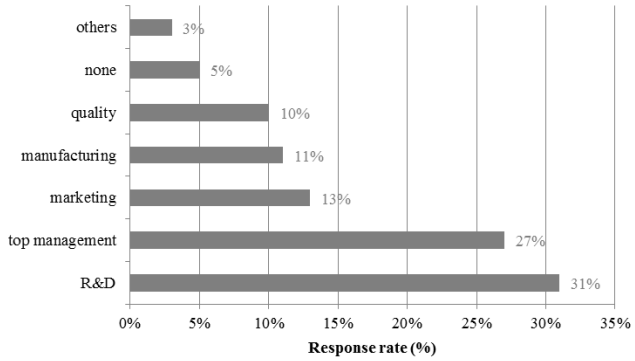

Fig. 13 Responsibility for environmentally friendly products development (ecodesign)

Further results reflect the focus that is placed by producers in environmentally friendly products development (ecodesign). The answers are as follows:

- reduction of energy consumption, emissions reduction and increased use of renewable energy;
- possibility of recycling, decomposition, and biological treatment
- compliance with legislative requirements and quality;
- customers' expectations regarding the use and acceptance of product quality level in the company and the possibility of a technological process of production;
- avoidance of the procedures that deviate from standard-technology production path, considering standards and BREF in the case of projects and investments;
- take into consideration the possibility of sales, costs, price for materials and resource consumption;
- use of resources that are environmentally friendly and harmless to health;
- reduction of hazardous substances.

The results presented in the Fig. 14 show the benefits of the ecodesign from the producer's point of view. Based on the results the areas where organizations see benefits follow as: waste minimization (25%), emissions (20%), energy (17%), production (15%), image (12%), sale (7%), other (2%) and nowhere (2%).

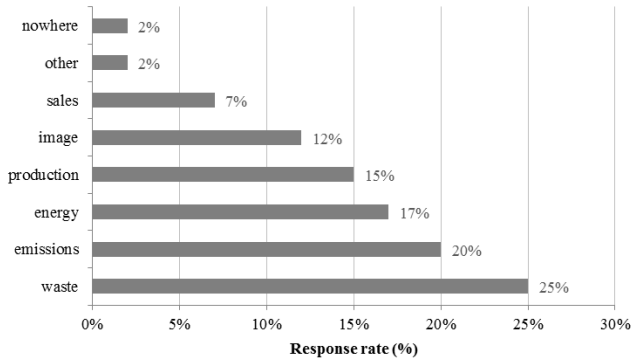

Fig. 14 What are the main benefits of EcoDesign activities?

In the context of perceived term "environmentally friendly product", both producers as well as customers who participated in the survey agreed that this term recalls in particular on the characteristics of products and services, and other terms that are related to environmental protection. As expected, the producer's point of view is perceived as being linked to the product that exceed product characteristics in terms of environmentally friendliness. Such a product should:

- include appearance attributes of a product that reflect the commitment of organization to environmental protection;
- be made out of environmentally friendly and natural materials;
- has a minimal negative impact on the environment during the production, use and recycling
- be less harmful to the environment in comparison to the convential product, should have a high recycling rate and should not pose any risk to human health;
- consider product life-cycle and should be made by using renewable resources;
- protect environment in terms of emissions and effluents into air, water and soil; and the use of non-renewable resources should be minimized;
- not cause any harmful side effects (for human and the environment) during its lifetime;

Like producers, also customers perceive green product as a product that is made from natural materials (environmentally friendly, without toxic additives) and produced by processes that do not pollute the environment, not exploit people, and consume less energy.

It is interesting that customers place stronger focus on minimal packaging which should be environmentally friendly and biodegradable as well as recyclable and should be reusable. Moreover, the green product is from the customer's perspective conceived and associated with a green colour, solar cells, the nature, quality of life, organic products, organic production, impeccable water, the ozone hole, harmless to the environment, content without additives, homemade vegetable, fresh air, forest, and something that is up to date with the latest trends and which should be considered in many new products categories.

The results show that customers (29%) and producers (31%) agree that companies with products that are friendly to the environment gain the customers trust (Fig. 15). The results presented in Fig. 15 also indicate a discrepancy between customers and producers perspectives. According to the customers' point of view, enhanced reputation (33%) is the most important benefit, while surveyed producers believe that customers trust is the most important benefit. The customers' assumption that companies with environmentally friendly products increase costs (23%) is not the case according to the producers – from their point of view, companies gain a higher reputation in society (25%). Although customers believe that producers with environmentally friendly products achieve higher sales (13%), the producers disagree with this statement. Preparation for compliance with legislation, competitive advantage due to the conscious customers, a condition for further production in industry and in Europe, company's existence on the market and the possibility of sales in competitive markets in the EU, are other benefits (12%), which the producers receive by producing the environmentally friendly products.

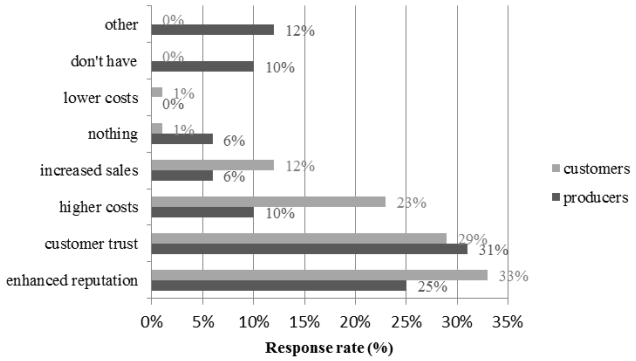

Fig. 15 The benefits for producers due to environmentally friendly products – comparison between surveyed customers and producers

Subsequently, a question has been given to customers regarding the following criteria: energy consumption during product usage, the environmental impact of the end-of-life product, recyclability, the use of environmentally friendly materials and environmentally friendly manufacturing process. Given criteria were ranked according to the customers in the following order (Table 1): the possibility of recycling, the use of environmentally friendly materials, energy consumption during product usage, the environmental impact of the end-of-life product, and environmentally friendly manufacturing process (lower mean values indicate greater importance). As shown in Table 1, the same criteria were ranked according to the producers as follows: energy consumption during product usage, the environmental impact of the end-of-life product, the possibility of recycling, the use of environmentally friendly materials and environmentally friendly manufacturing process.

Table 1. Ranking of given criteria (expressed in mean value)

	Mean value	
Criterion	**customers**	**producers**
the possibility of recycling	2,6	3,0
the use of environmentally friendly materials	2,8	3,1
energy consumption during product usage	2,9	2,6
the environmental impact of the end-of-life product	3,0	2,7
environmentally friendly manufacturing process	3,8	3,6

IV. DISCUSSION

According to the research results, quality, usability and practicality are the highest ranking product characteristics from the customer's point of view as far as product development is concerned. All the other answers indicate a

positive attitude of respondents to the environmental protection as they include only characteristics that are related to environmental protection. These findings are consistent with the work of Park and Tahara [70], who indicate that a product must meet the basic requirements of a market and therefore meet customer's expectations. While producers want to meet customer's needs and expectations, they also want to make higher quality products with minimum production cost. Therefore, for the producers, product value can be defined as product quality versus cost. The improvement of product value can be accomplished by the improvement of product quality, the reduction of production cost, or the accomplishment of these two aspects simultaneously [70].

It is also indicated that environmental concern is reflected in the attitude of customers to product development as well. 86 percent of respondents identified the importance of environmental protection in product development as very important (score 5 out of 5). Furthermore, the results showed that 72 percent of customers would choose the product which is more environmentally friendly. Positive attitude towards environmental concern is also highlighted due to the fact that the vast majority (97%) of respondents agree that they can indirectly influence the environmental protection by buying a green product. Nevertheless, it should be considered that customers who prefer the benefits of environmentally friendly products may not necessarily have motivation to purchase them [23]. Author suggests that for these customers any brand will do, hence there is no environmental information search involved when it comes to choosing their brands and green product labeling may not be meaningful to them. These customers would perhaps trade off product attributes such as quality, warranty and performance in their product alternatives evaluation and selection process [24].

The results also show that customers in generally would prefer eco-products in spite of higher prices. More than a half of survey respondents (54%) expressed the willingness to pay more for a product in comparison with product that is considered as less eco-friendly. Mintel [65] found that despite pro-environmental attitudes, intention to recycle, concern about pollution and willingness to pay more for environmentally-friendly products, few customers translated these attitudes into regular green buying behavior. Gupta and Ogden [33] reveal that several characteristics of the individual – trust, in-group identity, expectation of others' cooperation and perceived efficiency – were significant in differentiating between "non-green" and "green" buyers. Laroche et al. [50] revealed in their research study that customers who are willing to spend more for green products perceive that is very important to behave in an ecologically favorable way. Thus marketers should communicate to the target audience that buying green products can have a significant impact on the welfare of the environment. In addition, the authors found out that customers who are willing to pay a higher price for green products believe that firms do not act responsibly toward the environment. Therefore, managers should persuade customers that the protection of the environment is not the sole responsibility of business and that each individual can also make a difference. It is also important for marketers to provide positive feedback to customers on a regular basis in order to show them that they really are making a difference. These actions would not only reinforce proper behavior of green customers, but could also motivate less ecologically friendly individuals to behave in a more conscious manner [50]. With regard to the marketing communication, Pooley and O'Connor [74] argue that providing information on environmental issues does not necessarily foster pro-environmental attitudes. Their research suggests that the key to environmental education is the affective domain.

Among the criteria that influence the purchase decision, customer's need is the most important one, following the product quality, price and environmental friendliness as the fourth criterion. Trend and fashion have the least influence in the purchase decision. These results are consistent with the answers to the question, where the criterion quality was ranked ahead of the product characteristics regarding the environmental protection. These results are similar to research work, where the criterion "environmental responsibility" was ranked to the fourth or fifth place according to the importance of purchase decision. Hence, the organization Electrolux for example tries to associate the efficient use of energy with the term "green" and thus classified products as environmentally friendly [56]. The results are also supported by the research work of Peattie [72], who indicates that if a product does not meet the basic requirements, then the product will fail in the marketplace even if it causes less stress on the environment. Kärnä et al. [44] indicate that satisfying the needs of customers in a profitable way is the core of marketing ideology and in turn is a core of the market economy. Environmental or "green" marketing has been seen as a tool towards sustainable development and satisfaction of different stakeholders [44].

As can be seen from the results, customers placed in the purchase decision the price ahead of the criterion that describes a product's environmentally friendliness. This result is to some extent also reflected in the decision to purchase a product that is environmentally friendly, since a relatively small percentage (20%) of respondents always decide to purchase such a product, while 76% of the respondents sometimes decide to purchase a product and 4% rarely decide to purchase environmentally friendly product. Green Gauge report (2002) stated that fully 48% of Americans say they have purchased a product because it was labeled environmentally safe or biodegradable. Unfortunately, actual sales results do not support such research results [56]. Likewise, Philips in its research found a great interest in green - (50% positive, 25% neutral and 45% of respondents appear to have positive attitude to green marketing efforts. Unfortunately, there is a much smaller percentage of customers who are willing to change their lifestyle (20%) or willing to pay more (25%) for green product. As stated by Gordon [30], 30 percent of people claim to be concerned about the environmental and ethical integrity of products and services they purchase and yet only 3 percent translate this attitude into their behavior.

In the context of environmentally friendliness, green product implies to the characteristics of products and services, and other terms that are related to environmental protection, as was perceived by customers and producers. The green product is

from the customer's perspective associated with a green colour, solar cells, the nature, quality of life, organic products, organic production, etc. As indicated by the study [41] among Romanian consumers, consumers in most cases associate their health with green products, while only few of them think about wider benefits of green products.

The results show that 55% of organizations have already introduced one of the environmental management system (EMS) standards (according to the results, ISO 14001 prevails among organizations by 52%). The results can be interpreted as a good starting point for effective integration of ecodesign activities as well as can be seen as an important contribution related to CSR. This is consistent with previous works [8]-[43]-[98] indicating that a certified environmental management system (ISO 14001), leads to an increase in environmental planning activities (design for environment - DFE). Some other studies indicate a week connection between environmental management systems and ecodesign [2]-[81].
In essence, environmental management sets out to answer the question of how companies can increase their environmental effectiveness and efficiency [21]. It focuses primarily on how the environmental problems caused by business can be overcome, taking into consideration various environmental management systems (ISO14000, EMAS etc.). The case study in Greek industry [22] indicate that the enterprises by implementing the environmental management systems and especially the European EMAS, can succeed in developing innovative systems, being sustainable, complying with the law and informing different target groups inside (employees) and outside (local authority, consumers) about environmental management. Moreover, EMS standard can also be integrated with ISO 9000 Quality Management System (QMS) standards in order to achieve excellence in quality as well as environmental targets [101].

Still, recent environmental management concepts have attempted to broaden the term "environment" in the context of "human living conditions" [85], thus placing society in the realm of the environment, at least indirectly. In corporate environmental management, however, the impact of business on stakeholders and society is largely perceived, and discussed, as the indirect impact of organizations on humans through their influence on the ecological environment [21]. Thus, corporate social responsibility (CSR) requires that corporate activities should be made more environmentally friendly [70].

In the present study, we found that among the factors that encourage organizations to introduce an EMS standard, concern for the environment, competitive advantage, legislation and customers' attitude are the prevailing factors. Pouliot [77] highlights the importance of a market perspective and therefore indicates that some organizations see the certification according to ISO 14001, as a mean of competitive differentiation, which could be done by creating an environmentally friendly image. The usefulness of EMS as a tool to manage environmental issues in companies is a question of interest to many different parties [67]. As stated by authors, one of the most interested groups conceivably is the companies themselves, who invest large amount of resources into the implementation and operation of the EMS. As a natural follow up they increased environmental work, but also the general value of the standardized EMS as recognized on the relevant markets. Companies are also interested in environmental management done in other business establishments. One of the reasons is to benchmark with competitors on the market [76]. Another growing trend is to demand ISO 14001 certificate from suppliers. Considering the negative effects of EMS standards, 32% of respondents expressed that introduction of EMS standard leads to more paperwork. A possible explanation is that, the benefits of acquiring ISO 14001 certification are not clearly understood, particularly its long-term and external benefits.

However, according to the results, the EMS standard is not considered as the only way by which a company can contribute to the environmental protection (addressed by 60% of respondents). This result can be interpreted due to the fact that there are many different environmental protection approaches that can be taken in order to foster environmental initiatives, such as: corporate social responsibility (CSR), environmental management accounting (EMA), green public procurement (GPP), life cycle assessment (LCA), environmental benchmarking, environmental reporting, ecodesign, environmental awards, etc.

According to the results, 60% of respondents have developed a procedure for environmentally friendly product design (ecodesign), which is the same proportion of those who already have experience with the introduction of the environmental management standards. Reading through ISO 14001 it is clear that product development is not emphasized and that most product-related requirements leave substantial room for interpretation [3]. This suggests that we cannot conclude to which extent "normal" EMS includes environmental aspects, and thus affect the impact that a product has on environment.

There are several departments within the organization that are involved and take responsibility for environmentally friendly products development (ecodesign). Results presented in Fig. 12 and Fig. 13 indicate that ecodesign is performed in cross-functional teams. Top management commitment and support is also a factor that could be interpreted as important one. These results are consistent with the work of Johansson [42], who provided an extensive overview of success factors for the integration of ecodesign in product development.

The results indicate that concern for the environment is the most important criterion with regard to introducing the ecodesign concept into product development process, following by better image and competitive advantage. As stated by the Moore and Manring [66], organizations of all size are increasingly being confronted by multiple external stakeholders to demonstrate a commitment to corporate social and environmental responsibility (CSR/CER). Social and environmental responsibility is a dimension that needs to be clearly communicated to both customers and the general public [88].

Results from our research indicate that waste minimization, emissions, energy and production are the key areas where organizations see the benefits of environmentally friendly

design. As stated in literature [7]-[84] the eco-design is concerned with the development of products which are more durable, energy efficient, avoid the use of toxic materials and which can be easily disassembled for recycling. It is clear that eco-design provides opportunities to minimize waste and improve the efficiency of resource use through modifications to product size, serviceable life, recyclability and in use characteristics [53]-[99]. According to the Rao and Holt [80], greening of production leads to savings in raw materials, water and energy usage and thus leads to competitiveness and economic performance. The results also show that both customers and producers agree that enhanced reputation and customers trust are the most evident benefits of being environmentally friendly. According to the results, enhanced reputation is the most evident benefit obtained from green products considering customers' point of view. Other answers were linked to the customer trust, higher costs, higher sales and lower costs. It could be argued that when reputation is good, organization has competency to satisfy the customers' needs and expectations, and thus it develops customers' trust. However, it is obvious, that customers' and producers' thinking is not yet directed toward possibilities and opportunities of creating sustainable value. Indeed, addressing the full range of sustainability challenges might be considered as a driver for sustainable growth in the future.

In evaluating the environmental impacts of a product, some might want to identify the key environmental life cycle stage of a product, while others might want to identify the key environmental component or material of a product. Therefore, companies have to determine which level of key environmental issues will be identified [70].

V. CONCLUSIONS

This research outlines the practices that are taken by surveyed organizations with regard to the environmentally friendly product development. Moreover, this research also explores the customers' awareness of the importance of protecting the environment considering green products. The research highlights a number of important perspectives that are crucial in supporting the successful integration of ecodesign in the product development process. Some important points identified by the survey include:

- It is imperative to include marketing and design jointly in early design in order to understand the custumer's needs and expectations. The research has shown that customers place the importance on quality, usability and practicality regarding the product development, which is consistent with the findings that customer's need is the most important factor in the purchase decision, following the product quality, price and environmental friendliness.
- Environmental awareness and responsibility are reaching a high level of awareness among customers and producers. In fact, environmental concern was ranked as the most important reason for introducing the ecodesign by producers, while customers identified the importance of environmental protection in product development as very important.
- EMS standards is not the only way by which a company can contribute to the environmental protection. The use of many different environmental protection approaches in this manner would complement, not compete with the purpose and objectives of EMS stanards.
- The producers have identified the significance of including ecodesign in the pre-specification stages of design. Research and development department (R&D) is considered as essential in environmentally friendly products development. Cross-functional involvement and top management commitment is also considered as an important factor for the integration of ecodesign in product development.
- Another important result emerged from our study concerning the comparison of the benefits of ecodesign between customers and producers. Taking into consideration the customers' point of view, enhanced reputation is the most important benefit, while surveyed producers believe that customers trust is the most important benefit. Nevertheless, the research findings indicate that customers and producers are not aware of the wider sustainability issues.

The importance of addressing the environmental dimension in product development, therefore, should be considered by producers. Green products should be comparable in price, brand, usability and performance to "traditional" products. In order to succeed, product must meet the customer's needs and expectations. A balance has to be found between the customer's needs and environmental dimensions of product, such as: the possibility of recycling, the use of environmentally friendly materials, energy consumption during product usage and the environmental impact of the end-of-life product. Nevertheless, to consider environmental issues, it is necessary for producers to understand the benefits of environmental friendliness, unless they strongly believe that the customer demands it in the product.

VI. FURTHER RESEARCH

Future research in green development could be more specific in how effectively and efficiently integrate the sustainability issue into the product and process design in order to increase organizational performance. From organization' perspective green development should not be represented solely by environmental performance, but also by organizational performance and sustainability.

The transformation of the product development process by taking into consideration elements of the entire organization and wider aspects will be a challenge for the NPD process. Hence, a better understanding of linkages between quality management, sustainability and organizational performance, would help in integrating environmental issues effectively into companies' NPD process, and can therefore contribute to the pursuit of sustainability.

Future research could also look into the possibility of identifying the relationship and potential synergies between quality management and corporate social responsibility (CSR).

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