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TELEOLOGICAL AND DEONTOLOGICAL JUDGMENT OF CLIMATE-RELATED INNOVATIONS: MANAGERS' PERCEPTION STUDY

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Abstract

Ethical perception of innovations is a research area which has been advocated as a suitable topic for study in recent years. Its focused on moral judgement (recognition that innovation has an ethical dimension), moral decision making and actions. From the point of view of climate change and climate-related innovation the ethical perception affects the involvement in the process of its implementation. In this paper, we use the context of climate change to explore the relations between ethical interpretation and innovation in more detail. The article aims at presenting considerations and research findings dealing with perception of climate-related innovation from the ethical perspective. We use the exploratory cluster analysis to develop a set of propositions to explain when interpretation in terms of opportunities, threats or concern may, in fact, encourage innovations. The population of the analysis involved 750 organizations. We present two mediation mechanisms (teleological and deontological); these are individual moral obligations and seeking for social legitimacy. At the center of a deontological approach, there are principles of justice, basic rights, duties, obligations, responsibilities, proper conduct, and inherent natural rights of others. Teleological judgement lies in assessing its consequences and looking for a social legitimacy thanks to emphasizing positive effects. The paper contributes to the literature by identifying ethical aspects relating managerial interpretation to climate-related innovations. Firstly, it extends the theory of innovation management to the ethical aspects of climate-related innovations. Secondly, the paper provides empirical evidence regarding the perception (in ethical and managerial terms) of climate-related innovations by managers.

Key words: climate change, deontological ethics, innovations, teleological ethics

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1. Introduction

From the philosophical perspective, climate change raises a significant ethical problem which needs to be addressed by individuals, business entities and institutions who are morally obliged to do this (Comest, 2010). The response may take the form of preventing climate change or minimizing its impact. On the other hand, entities affected by climate change do not often feel they have such an obligation which results from a negative perception and interpretation of both the phenomenon of climate change and response activities (Harvey Nash Board Report, 2020). Consequently, their behavioral and emotional involvement in initiatives to prevent climate change varies considerably (Lorenzoni et al., 2007). In this paper, our focus is on an ethical judgement and interpretation of climate-related innovation which provides the most proper solutions for preventing and minimizing impacts of climate change at the level of the organization (Bosetti et al., 2014; Johnstone and Pilat, 2015).

Interpretation gives the basis for a decision-making process and, as a result, behaviors. According to the cognitive categorization theory, perception and motivations systematically affect the processing issues and the types of organizational actions taken in response to them (Dutton and Jackson, 1987). From the perspective of climate change, perception of both climate change and adjustments made by decision-

makers shape managers, organizes their knowledge and experience (Peng and Liu, 2016). The cognitive representation of the climate change issue translates into further behaviors depending on an individual interpretation (either an opportunity or a threat). The ways in which individual, societal, and polities respond to climate change are in many cases contingent on many perceptions of its causes, consequences and implication. As such understanding of opinion on climate change is critically important (Capstick et al., 2015). Public attitudes to climate change and policy options have been well documented in literature (Engels et al., 2013; Slovic et al., 2000; Spence et al., 2010; Steentje et al. 2017; Tvinnereim and Ivarsflaten, 2016). Some of the authors raise the issue of managers' perception the phenomenom of climate change (Rodriguez-Franco and Haan, 2015). While the public's understanding of climate change has been studied in some depth, little research has examined solutions dedicated to mitigation/ adaptation activities to climate change. Meanwhile the way they are perceived and assessed determines the diffusion process.

The idea of assessment of innovations meeting ethical values is not new. Responsible Research & Innovation continues the ethical reflection on technology and research, as framed by ethical legal and social impacts and assessment (ELSI and ELSA) initiatives. In addition, reflections on corporate social responsibility (CSR) and sustainable development have also paved the way for the inclusion of ethics in the shaping of innovation. Authors such as Grunwald (2011), Stilgoe et al. (2013), Von Schomberg (2013), or a report from the European Commission (EC, 2013), have gathered recommendations and guidelines for assessing the technical solutions in terms of responsibility and ethics. Although the development of this approach, the concept of technical evaluation of innovations has remained surprisingly under-investigated (Pellé and Reber, 2015).

Up until now, the studies on ethical assessment of climate change have focused on the phenomenon itself (Brown and Taylon, 2014; Gardiner, 2011; World Commission, 2010), or justification adaptation action on ethical grounds (García and Sanz, 2018; Harris, 2011; Lacey et al., 2015; Schroeder et al., 2012). Referring to climate-related innovations Haney (2017) explores how the interpretation of risks, which is the ability to sense, influences innovation. Todaro et al. (2020) examine awareness of climate change and perceived exposure to climate risks as antecedents of corporate responses to climate change. Although recent literature has provided initial explanations for managerial cognition perspective of innovations, the research explaining how ethical interpretation can support organisations to climate-related innovative solutions are missing.

In order to fill this gap, we will investigate what mechanisms influence the intentions of implementing climate-related innovations in organizations. The article aims at presenting considerations and research findings dealing with managers' perception of climate-related innovation from the ethical perspective. This is important in as an ethical judgement may play a key role in shaping decisions on implementing or rejecting innovation. Understanding the perceptions of managers regarding climate change-related innovations may suggest the likelihood of their participation in adaptation and mitigation activities, as well as in educational opportunities (Jones and Lenart, 2014).

The paper contributes to the literature by identifying the importance of ethics in relation to interpretation of climate- related innovation. Firstly, the paper extends the theory of innovation management to the ethical aspects of climate-related innovations. Based on the positive theory of ethics, it presents the ethical basis for judgement of innovations in the context of climate change. Secondly, this paper presents the results of an empirical study on managers' perceptions of climate-related innovation. Based on these, a coherent framework is developed to disclose deontological and teleological mechanisms underlying the perception of climate-related innovations.

The paper is structuralized as follows. In the first sections, we present the concept of climate-related innovations, their ethical aspects and theories underlying the paper. The analytical, multi-step approach is presented in the method section. First, we present empirical findings that inform the identification of ethical mechanisms linking the interpretation and implementation of climate innovation. The considerations presented provide a basis for hypothesis building. We conclude by summarizing the implications, identifying limitations of the study and discussing the main directions for future research.

2. Literature review

2.1. From ecological innovation to climate - related innovation

Eco-innovation answers the increasing calls for the use of new and renewable energy sources, energy efficiency and to reduce carbon emissions (Lema et al., 2014). These are solutions planned with the intention to minimize the environmental effect of manufacturing, consumption and discarding activities, even if their primary incentive is to capture opportunities and take advantage from environmental issues (Neto et al., 2014).

In the literature there are two approaches to eco-innovation considering it as:

1) an instrument for implementing sustainable or environmentally oriented development,

2) a mechanism for improving environmental and/or economic performance (efficiency approach). In the first perspective, eco-innovation is a policy instrument for reducing negative environmental impacts. One of the often referred definitions of eco-innovation in this approach is the one proposed by Rennings (2000) "all measures of relevant actors

(firms, politicians, unions, associations, churches, private households) which: develop new ideas, behaviors, products and processes, apply or introduce them and which contribute to the reduction of environmental burdens or to ecologically specified sustainability targets". Eco innovation refers to all forms of innovation: new skills for environmental enhancement, new processes, new products and services, new business forms, etc. Moreover, any activities related to reducing negative impacts or enhancing positive influence on the environment while minimizing use of natural resources are all part of eco- innovation (Charter and Clark, 2007; Kemp and Pearson, 2007; Rennings, 2000; Schiederig et al., 2012). Another group of definitions refers to benefits/losses of eco-innovation. In particular, the literature refers to numerous environmental benefits that may constitute a fundamental objective of innovation. Definitions from this group emphasize the fact that more efficient use of energy and resources leads to the reduction of the consumption of raw materials and energy as well as reduction of waste. Additionally, some definitions point at social benefits such as e.g. improvement of life quality and economic benefits, e.g. reduction of direct costs or the ability to attract green rents of the market.

Climate-related innovation is a part of eco-innovation, the aim of which is to reduce impacts on climate and reduction of CO_2, in particular. It relies on continuous improvement of products and processes to minimize climate impacts and to give the firm a cost-based competitive advantage. These innovations represent improved or new products with low emissions (Haney, 2017). Nowadays, Climate-related innovations are seen as a basic tool for reducing carbon dioxide emissions while taking into account cost-effectiveness (McJeon et al., 2012), as well as a solution positively influencing energy security, environmental protection, and economic growth (Harmon and Cowan, 2009; Nuttall and Manz, 2008; Palma and Coletta, 2011). In particular attention is paid to the synergy between approach for mitigation of air pollution/climate change and sustainable development includes meeting the needs of the population (Ramanathan, 2014; UN Report, 1987). Nevertheless, although the number of environmental programs and initiatives is increasing, the development and diffusion of climate-related innovation still remain limited, being largely dependent on public interventions (Johnstone et al., 2010).

Climate-related innovation falls into two categories: mitigation and adaptation. Mitigation innovations aim to reduce emissions of greenhouse gases or to capture them, while adaptive innovations allow users to adjust to negative effects of climate change, or exploit positive ones. In this paper we focus, in particular, on technical innovation, representing mitigation technologies (limiting greenhouse gas (GHG) emissions, energy consumption and aimed at redesign the global energy system (e.g., solar cells, electric engines) (Eckman and Stackhouse, 2012; Hoggett, 2014). These innovations simplify or change the usage of existing techniques or technologies, or rely on the implementation of new technologies. Unlike other types, climate-related innovations have two inherent features– the creation of economic and environmental value. Within the economic value domain, the climate-related innovations enable value capture (i.e. economic returns) and value creation (i.e. provision of a high-quality product) and research indicates that this type of innovation contributes to economic performance of organization (Dong et al., 2014). The environmental value focuses on the environmental impacts of climate-related innovations throughout mitigation technologies and programs (Mensah et al., 2018).

The academic literature on climate-related innovations is still limited and the studies undertaken have been relatively narrow both in their scope and focus. Most of the literature has analyzed the extent to which international stimulative (f.e. Clean Development Mechanisms) contribute to promote innovation transfer to developing countries (Dechezleprêtre et al., 2008; Haselip et al., 2015; Lema and Lema, 2013). Some researchers refer to a R+D stage (Bosetti et al., 2011; Costa-Campi et al., 2014). Another research area deals with factors influencing the absorption of climate-related innovation (De Coninck and Sagar, 2015; Kolk, 2013). It therefore becomes clear that the transfer of climate technologies is subject to very different motivations and incentives: ranging from financial, environmental to social ones. Taking into account individual motivation, attention should be given to ethical imperatives encouraging implementation of climate-related innovation (Nicolaides, 2017). Previous studies show relations between ethics and climate-change (Besio and Pronzini, 2014; Fussel, 2009).

2.2. Ethical aspects of climate-related innovation

Over the past twenty years, a number of moral philosophers (among others) have explored whether anthropogenic climate change involves questions of good and bad, right and wrong, responsibility and blame (e.g. Long, 2011). The normative approach considers why climate change is an ethical problem and whether it constitutes a moral imperative (Broome, 2008; Stern, 2006). These works confirm that the moral obligation of man to limit the causes and mitigate the effects of climate change results from their ethical dimension. Of course, it might be assumed that it does not pose a problem for the organization only, nevertheless such a stance would not be morally proper. One should rather expect organizations to rise to this challenge and to take responsibility for it (Knowledge & Wharton, 2017). Up to date, climate-related innovation has been the most effective solution to the problems of climate change (see Best Climate Solution Award). However, apart from its obvious benefits, it has also, its 'dark side'. It might give rise to moral issues, which leads

to moral corruption (Gardiner, 2006). It results from such characteristics of innovation as institutional inadequacy' (problems of the commons), temporal and spatial dispersion of causes and effects, discounting prospective value, innovation risk. These features may lead to unethical behaviors, despite perceiving climate-related innovation as ethical. Innovation may also be viewed as subject to risk. In this event, decision makers attempt to postpone taking decisions on innovation, being aware, however, of their necessity. Therefore, from the ethical point of view climate-related innovation is significant for a few reasons. Firstly, climate-related innovation is consistent with corporate social responsibility policy. It meets the needs for improving the current state of the environment and preventing future losses. From the social perspective, it affects the health of the population and well-being. Therefore, if a company wants to be perceived as environmentally and socially responsible, it has to take measures to reduce carbon emission through, among others, introducing innovation (Rosen-Zvi, 2011). Secondly, companies implementing innovation on a voluntary basis prove their high moral legitimacy. Firms that seek moral legitimacy from their stakeholders are concerned with identifying what is the right thing to do. Ecological innovations are viewed as useful socially, nevertheless not generating financial profits. Yet, they allow to gain moral legitimacy as they respond to the needs of many groups (Scherer and Palazzo, 2011). Thirdly, climate-related innovation, referring to the concept of Singer (2006), has the impact on the distribution of a scarce resource, i.e. clean air. If these GHG emitters do not compensate losses by applying pro-ecological innovation, they limit access to resources of clean air, and it makes them immoral. Such a 'theft' of air brings about physical and psychological losses for others (Doherty and Clayton, 2011). The above assumptions confirm the ethical dimension of climate-related innovation.

2.3. Theoretical framework

The ethical judgement of climate-related innovations can be interpreted (at least) from the perspective of three theories. These theories form the basis of our reasoning.

2.3.1. Corporate Social Responsibility and Responsible Innovation

Corporate social responsibility (CSR) involves the conduct of a business so that it is economically profitable, law-abiding, ethical and socially supportive" (Carroll, 1983). CSR extends the horizon of private organizations beyond their traditional profit maximization behaviour and encouraging them to consider the social impact of their activities. The increased consciousness of market participants with regards to environmental and social issues coupled with the intense product market competition led to a twofold pressure: moral and strategic. The moral pressure is a tool used by stakeholders to publicly shame organizations that behave in a socially irresponsible manner. While firms have the right to sell goods to consumers, they have some responsibilities to behave ethically (Hou, 2019). Simultaneously, the strategic pressure is based on the argument that CSR should be designed and implemented to promote differentiation at the product and firm levels, and thus enhance firm's competitiveness. Noticeably, the moral part (complying with social and legal norms) goes hand in hand with the imperatives of economic performance. The adoption of the CSR philosophy has a significant impact on innovative activities in the organization. Different researchers recognize the existence of an association between CSR and innovation (Kraus et al., 2020; McWilliams and Siegel, 2000; Zhou et al., 2019).

The basis of innovative activity is also the interest in the CSR concept, which involves the social and environmental impact of organizations in the stakeholders concerns, stimulate the creativity of their workforce, and cooperate with their stakeholders. CSR-driven innovation has as its end result products and services that have some sort of social or ecological purpose. Pavie et al. (2014) scrutinize a number of issues and examples that show how CSR can be applied practically. It can shape innovation by challenging the private company's ceaseless quest for new goods, through a careful monitoring of a product's life cycle, or by anticipating and monitoring the medium and long terms consequences of a given product on health, lifestyle, or on the environment. Pellé and Reber (2016) indicate that CSR may well be useful for the implementation of responsible innovation's main features (i.e. responsiveness, anticipation, inclusion or reflexivity). Going further, as climate-related innovations are responsible innovations, dimensions derived from the concept of CSR, are also at the heart of them.

Referring to climate-related innovations, note that anticipation concerns potential intended or unintended impacts of innovation. In particular, the organization should focus on the effects that an innovation could have on the GHG emissions volume. Reflexivity requires organizations to reflect on values and motivations that drive their business (Owen et al., 2013). In the era of climate change, this motivation may be the improvement of the organization's emissions performance.

Inclusion is about including a wide range of stakeholders in the innovation process, which will allow better understand the perceived risks and benefits of an innovation to society. Responsiveness, in turn, refers to the ability of an innovating company to adapt or change its direction in response to stakeholder and public values. As climate change adaptation plays important role in public debate, activities undertaken by organizations in this area respond to social expectations. In the context of climate-related innovations CSR provides framework to deeper understanding of the character of

responsibility and can be a canvas to combine different meanings of responsibility and innovations for climate protection.

Responsible innovations (RI) are an expression of an organization's responsibility. According to definition responsible innovation is a transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society) (Von Schomberg, 2013). Procedural approach focuses on the conditions that RI processes should satisfy in order to be considered as. Five dimensions are more frequently investigated in it (Burget et al., 2017): anticipation (using traditional rational tools to deal with uncertainty), responsiveness (conceived of as constant adaptation to a changing environment), reflexivity (thought of as the ability to challenge the framing through which assessments and decisions are made, inclusion (which calls for participation and sometimes deliberation as a possible means to align science and technology with societal values) and transparency (i.e. the need to circulate knowledge). The assumption is that the ethical aspects of RI emerge from these dimensions. Assuming that RI have a wider scope than the concept of CSR. European Commission points out that CSR could become an additional RI pillar (EESC, 2016). However, for several authors CSR provides a basis to develop the conception of responsibility in innovation and its useful for the implementation of RI's main features (Stilgoe et al., 2013; Martinuzzi et al., 2018; Van den Hoven, 2013).

"The key" to RI is responsibility. Scholars attempt to address this feature under innovation process. The responsibility aspect is included in the innovation process phases – input, throughput and output – where the stakeholder dialogue and engagement follow (Nathan, 2015). Literature also draws attention to other principles that RI seeks to follow: responding to social needs and challenges; (2) assessing alternative solutions in terms of beliefs, values, and ethical assumptions (Wickson and Carew, 2014; Koops et al., 2015).

There is no doubt that climate-related innovations are part of the RI stream. This is due to their four characteristics. Firstly, they contain an aspect of novelty. A number of international and governmental programmes accelerate deployment of existing technologies and emphasize moving the next generation of technologies that can address climate change from the lab to the market needs to be prioritised (Cervantes et al., 2018). Secondly, climate-related innovations are complemented by a dimension of impact on the external world. They have a direct and positive impact on the environment. Thirdly, if the general object of responsible innovations is innovation, the focus of investigation might be either on the process or the product. As indicated in section 2.1 climate-related innovations can be in product, process or organisational form and their inherent feature being the provision of economic and environmental value. Fourthly, they are based on the organization's responsibility towards society and the environment. Within the climate-related innovations, the "responsiveness" dimension brings to the fore the value of providing ethical solutions to existing and emerging organizational-level challenges. In the light of these characteristics, the concept of responsible innovations provides the platform for our further consideration of the ethical judgement of climate-related innovations.

2.3.2. Normative ethics

From the ethical perspective, the goal is first and foremost to make technological innovation free of any negative implications for the environment, human health and wider social wellbeing (Swierstra and Jelsma, 2006). Complying with the regulatory standards may be the simplest way to assure responsibility and ethicality. But, when an action is legal, it does not always mean it is ethical as well (Seglin, 2000). Ethicality goes beyond mere legal compliance. Normative ethics indicate that managerial ethical judgement on can be operationalized via teleological and deontological judgement.

Teleological ethical theories (consequentialism) analyze whether the actions taken are good or bad for society. Assessment is a function of the perceived effects of actions on stakeholders, the likelihood of these effects occurring, as well as their purposefulness and significance (Shang et al., 2008; Nordlander, 2020; Schniederjans and Schniederjans, 2015). This judgement also related to theistic foundation of perceiving the world and man, because „the approach to the climate problem and its consideration from the ethical–anthropological perspective, along withthe innovative proposal of intellectually substantiating the existence of God, far beyond belief or nonbelief in a personal sense, is seen by us as key to promoting an ethics of sustainability" (García and Sanz, 2018). In the context of this study, a teleological assessment concerns how the manager perceives the effects (purposefulness, significance) of climate-related innovations.

Deontological (non-consequentialism) ethical theories, such as ethics of duty (Kantian three Maxims) and theory of rights and justice, are concerned with whether a moral principle or motivation leading to right or wrong action (Baumane-Vitolinaa et al., 2016; Khalid et al., 2017). Ethicality is concerned with what is good and bad of an action towards the society in terms of its outcome (consequences). Deontological evaluation consists in comparing alternative behaviors with the individual's value system or perceived moral obligations (Shang et al., 2008). In this paper, as a deontological judgement, we adopt the manager's views on the compliance of the implementation of climate-related innovations with personal values or moral obligations. These theories can facilitate in resolving ethical dilemmas and whether an ethical concern is indeed ethical or

unethical. Nathan (2015) emphasizes that theories of normative ethics constitute the basis of ethical decision-making 'by an individual, including recognizing the ethical issue and making a moral judgment (see also Schlaile et al., 2017). Therefore, they can provide a platform for an ethical judgment of climate-related innovations by man-agers.

2.3.3. Value-Beliefs-Norms Theory

The Value-Beliefs-Norms Theory (VBN) was developed to help frame the investigation of relationships between pro-environmental behaviours and key explanatory variables such as personal values, beliefs, attitudes, and norms. The VBN theory is a framework built on three components: values, beliefs and norms, that determine behaviour in a causal chain. For the value components, Stern et al. (1999) simplified Schwartz's (1992) theory of basic values and implemented it to the VBN. Personal values include environmental worldviews; understandings of the causes and consequences of environmental problems; personal capacity to address those problems; and personal norms or sense of moral obligation to take action (Stern, 2000). Belief refers to one's thoughts about the natural environment and human behaviour, and has two components: awareness of consequences and ascription of responsibility. The third element of VBN theory are personal norms - feelings of moral obligation to preserve the environment. They also refer to the expectation that one is ethically obliged to engage in pro-environmental behaviour (Choi et al., 2015). At the end of the causal chain measures pro-environmental behaviour (Ghazali et al., 2019). These are actions that protect the environment or minimize the negative impacts of human activity on the environment; in this paper climate-related innovations.

Numerous scholars have widely used the VBN theory to explain the multiple pro-environmental personal practices (f.e. van der Werff and Steg, 2016). Others presented extended versions of these theoretical frameworks by integrating the main constructs from the theory of planned behavior (intention, subjective norm and attitudes) (Han, 2015; Gkargkavouzi et al., 2019). We adopt this approach by incorporating the intentions into our considerations.

2.3.4. Theoretical backgrounds for reasoning

Ethical judgments the climate-related innovation play an important role in motivating (or demotivating, in their absence) to implement them. Such an evaluation depends on a number of factors including relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003), perceived newness and perceived meaningfulness.

However, an evaluation of innovation through these criteria is not ethical. Ethical judgement of innovation is a process by which management must embed ethical decision-making framework within innovation governance (Nathan, 2015).

The judgement begins with the identification of ethical issues. It depends on the awareness of managers and the perception of ethical issues. It begins with an answer to the question of whether climate-related innovation include an ethical or moral issue. The positive answer requires further clarification, defining these values, such as the responsibility of the organization, justice, autonomy, well-being. The second stage is making moral judgement. It is based on theories of normative ethics; hence the evaluation concerns motivations leading to innovations (deontological ethics) and the outcome of innovation towards the society (teleological ethics). Ethicality is concerned with what is good or bad of innovations towards the society in terms of its outcome (health, safety, and economic). An important element of evaluation is also ethical risk analysis, which identifies risks, morally evaluates them, and puts forward risk management strategies that are justified from an ethical point of view (Arbuckle et al., 2013). Similarly, the ethical risk-benefit analysis takes into account ethical issues in determining and utilizing risk-benefit ratios for risks and potential benefits associated with innovations.

Although, the deontological and teleological ethical theories help make a moral judgement, most business managers tend to rely primarily on cost-benefit analysis of utilitarianism. This raises questions about opportunities, treats, efficiency. Climate-related innovation may be perceived as an opportunity or loss. The former refers to managers' awareness of the benefit of innovations, while the latter refers to awareness of the negative financial impacts. The cost-benefit analysis supports decision-making attempts to allocate resources efficiently, however, it cannot replace an assessment the potential ethical impacts on all stakeholders. Next step of ethical decision-making is establishing moral intent. It is equivalent to intentions, and at this stage a manager may weigh moral factors against other factors including self-interest. Even though this study pertains only to intentions, many researchers have agreed that intentions are significant indication of behaviours (Oreg and Katz-Gerro, 2006).

An ethical judgement of innovation depends on several factors such as the individual, the issue and the context-related and organizational factors. The subject of our research is perceptual, individual factors. They are based on one's worldview, gradually formed through lived experience which includes social conditioning – realism and ideas of 'good' life – idealism (Nathan, 2010). Blok et al. (2017) points out that the outcome of judgement is dependent on the stages of the individual's moral development. This paper alerts that managers also need to recognize ethical issues. Cognitive processes, i.e. managerial scanning, should therefore make sense - interpret - in ethical terms. In the context of climate-related innovations, such an assumption opens the door to research into their ethical analysis: a) does a judgement of climate-related innovation takes into account ethical aspects, b) how are they perceived (in

terms of benefits – threats).

The theories presented in this section provide a basis for seeking answers to these questions. We assume that if normative ethics theories can be embedded in the responsible innovations framework, it becomes possible to assess cognitive processes (perception) of climate-related innovations and normative mechanisms, which are located in them (Fig.1).

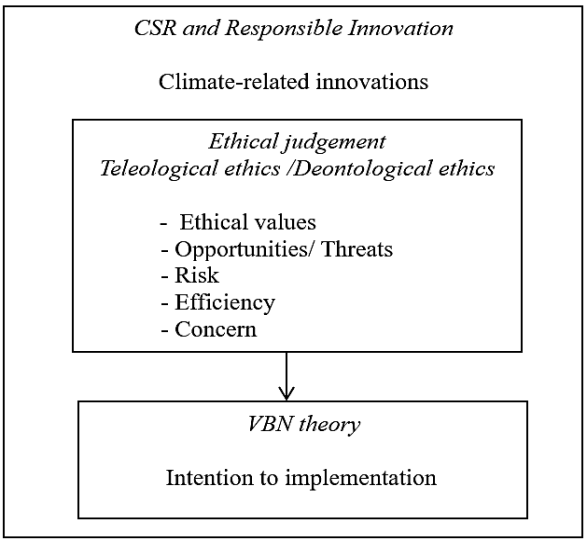

Fig. 1. Theoretical framework

3. Research method

3.1. Variables

The primary aims of study were: a) exploring perceptions about the ethical dimension of climate-related innovation; b) determining the relationship between the perception of climate change as an ethical problem and other constructs (e.g., risk, concern, efficacy); c) to determine if climate-related innovation is perceived in terms of benefits or threats for the organization.

In the research, the questionnaire method was applied. The participants were asked a variety of questions regarding their beliefs about climate-related innovation (dependent variable). The basic question posed was: Do you consider climate-related innovation to be an ethical or moral issue? We were not interested in the perception of climate change itself in the context of human health or environmental issues, but rather in functioning of the organization. We aimed at determining if managers view climate-related innovation through threats and are they aware of its ethical dimension. This question assumes great practical importance because of the need for the organizations to appreciate the significance of taking actions in response to climate change and its interpretation by managers.

An independent variable was interpretation in terms of opportunities, threats, risk and efficacy. Opportunities were connected with benefits, positive interpretation, while threats – with negative interpretation as a consequence of losses and costs. These categories were evaluated from the strategic perspective (Bitat, 2012; Xue et al., 2012). Opportunities of climate-related innovation refer to improving the company image, increasing market share, addressing social issues in the company and the value chain. The examples of threats are as follows: lack/ insufficiency of standards, high costs, depreciation of long-term investment, lack of cooperation in the fields involved, a problem with contracting, lack of information. Risk was limited to risk of implementation, i.e. potential problems (deviations from the assumed plans) which may appear parallel to stage of implementing innovation. Such a risk results from the lack of coordination during the implementation process, errors in documentation, a wrong choice of solutions, where high risk reduces the likelihood of implementing innovation (Bartoszczuk, 2018). An evaluation of efficiency, just as in the case of eco-innovation research dealt with associations between climate-related innovation and financial performance of companies (Ghisetti and Rennings, 2014). Efficiency of innovation was referred to the operational level (Arundel and Kemp, 2009; Rennings and Zwick, 2003; Wang et al., 2016).

Concern and ethical values were applied as control variables. Concern reflected a fear about climate in case innovation is not implemented. The question about ethical values was open-ended; the respondents proposed ethical values with which they associated climate-related innovation. The analysis of answers to these variables was carried out on the basis of a language dictionary, through the analysis of frequency of the words used. Table1 shows question wording and response categories of items discussed in the analyses below. Beliefs in the ethical dimensions of climate-related innovation were measured with the use of open-ended questions.

Initially, an English-language version of the survey elements was developed, which was pre-tested for content in two stages. In the first stage, we asked three experienced researchers to review the survey's position for relevance and ambiguity. After receiving feedback, the questionnaire was revised to improve the adequacy of the measurement. Then the questions were translated into national languages by native speakers.

In the next stage of the survey, up to 7 practitioners were sent out. They verified that the questionnaire items were appropriate for their current business situation. The pilot was attended by 7 deliberately selected organizations, which presented themselves as ecological and agreed to participate in the pilot. The suggestions made by the respondents were discussed with a research methodology expert. The result was a final version of the questionnaire.

3.2. Research sample

The population of the analysis involved 750 organizations from the FTSE4Good list.

Table 1. Variables used in the research

Domain	*Questions*	*Response categories*
Ethics	Do you consider climate-related innovation to be an ethical or moral issue? Do you feel personal responsibility for dealing with climate change?	Yes; No; Not sure For answers Yes/ No – explain why 4-point scale: Not at all, A little bit; Somewhat, Definitely
Opportunities	Does climate-related innovation generate opportunities for the organization?	5-point scale: Definitely Yes, Rather yes, Definitely not, Rather not, Not sure For answers Yes/ No – explain why
Threats	Does climate-related innovation generate market threats for the organization?	5- point scale: Definitely yes, Rather yes, Definitely not, Rather not Not sure For answers Yes/ No – explain why
Risk	Does climate-related innovation generate risk for the organization?	4-point scale: Yes very, Rather yes, Rather not; Definitely not
Efficiency	Does climate-related innovation contribute to mitigating the issue of climate change?	5-point scale: Strongly disagree, Somewhat disagree, Unsure, Somewhat agree, Strongly agree
Concern	If climate-related innovation is not implemented, how serious will the problem be?	5-point scale: Not at all, Not too, Somewhat, Very, Extremely
Intention	Does the organization intend to implementation climate-related innovations within 3 years?	5-point scale: Definitely yes, Rather yes, Definitely not, Rather Not sure
Ethical values	What ethical values may be associated with climate-related innovation?	Give examples (a few are allowed) – open-ended question

These companies were selected at random from the group 2099. FTSE4Good was designed to monitor listings of the companies representing the highest ESG standards and practices, i.e. environmental, social responsibility and corporate governance. Index reviews carried out by FTSE Russell are based on the activity and achievements of entities in such areas as corporate governance, health, safety in the workplace, anti-corruption operations or impact on the environment. As a reference point for company selection, the rankings of entities of the world highest level of emission was not chosen due to the low likelihood of implementing climate-related innovation by them.

In total, 72 managers completed the survey in whole or in part, of which 58 completed it in whole. It means 7.8% of a response rate. Using a confidence level of 95%, the sampling error amounts to 7%. The names of the companies are not given because of confidentiality clauses. The largest part of the research sample represented companies form such sectors as: capital goods (16%), food (13%), materials (12%), diversified financial (10%), consumer durables (8%), real estates (5%), utilities (5%), energy (5%).

3.3. Research process

The research process had a staged course (Table 2). Initially, after establishing the assumptions, a questionnaire was developed. It was pre-tested for content validity in two stages (subsection Variables). After the preparation of the final version of the questionnaire, the research sample was deliberately selected (subsection Research sample). The questionnaire was distributed electronically, directly to the selected respondents. To increase response rate, after 4 weeks of the questionnaire being distributed, respondents were sent 2 reminders, each four weeks apart. After receiving the returns, their completeness was verified. After an initial analysis of the data, an exploratory factor analysis (EFA) was conducted. Successively research results were analysed. The analysis of qualitative variables concerned open questions (domains: Ethics, Values - Table 1) and aimed at identifying the feelings and ethical issues declared in relation to climate-related innovations by respondents. It was based on the analysis of texts - answers (subsection Analysis of results). The analysis of quantitative variables (domains: Opportunities, Threats, Risk, Efficiency, Concern, Intention) was based on the clustering (subsection Analysis of results). Additionally, an analysis by sector was conducted at this stage (low and high emission sectors). Analysis of the results was the basis for identification of mechanisms relating perception of innovation to its implementation. The last stage of the research process was the formulation of hypotheses. The research process was based on an inductive approach that has been successfully applied in other perception studies (Neale et al., 2020).

3.4. Exploratory measurement results

Exploratory factor analysis (EFA) was applied and corresponding factor loadings were used to assess the convergent validity. Furthermore, EFA was used to check for any possible cross loading problems of the measurement items as well. The results show six factors with eigenvalues greater than one, accounting for 64% of the variance (K-M-O statistic 0.948; Bartlett statistic 435; significance 0.000). Thus the model adequately represents the data.

According to the results of the factor analysis, all factor-loading estimates exceeded 0.50 (ranged from 0.533 to 0.781). In addition, Cronbach's alpha and construct reliability were utilized to strengthen the EFA results (Table 3). Cronbach's alpha of the six factors ranged from 0.585 to 0.889 (Table 3). In case

of 3 constructs the alpha value was above the recommended value of 0.70, which is considered satisfactory for exploratory research (Hair et al., 2010). According to the results, for risk factors, effectiveness, and odds, Cronbach's alpha was below the recommended value, which may be due to the way it was estimated. It is a function that takes into account a number of items, so it could be some problems with this index when the number of items is very low (Koufteros, 1999). On the other hand, the fact that a company is included in the FTSE index proves that such a company has standards and practices of the environmental protection, thus, it might implement some innovation.

The sample selection targeted senior-level managers, as they were expected to have more comprehensive views of the strategic importance of activities against climate change. The scales for measuring contingency factors were subjected to convergent validity as well. The results of the factor analysis are illustrated in Table 4. The results show four factors with eigenvalues greater than one, accounting for 70,7% of the variance (K-M-O statistic 0.813; Bartlett statistic 66; significance 0.00). Following Hair et al. (2010), a significant value of 0.5 loadings is considered as a cut-off criterion. Almost all of items exceed the threshold of 0.50 for convergent validity. According to the results, one item (threat with cooperation with suppliers) was excluded from further analysis.

3.5. Common method variance

Since the study collected data on both the independent (Intention) and dependent variables from the same respondents, common method variance might be a potential problem (Podsakoff et al., 2003). As such, we used Harman's single-factor test by performing exploratory factor analysis on all of the measured variables and examined unrotated principal factor analysis. According to the results, the total variance for a single factor is less than 50% (i.e. 38.7%), thus it is suggested that common method bias is not a major problem in our data set.

Table 2. Research process

The conceptual phase	***Research phase***	***Results analysis phase***	***Interpretation phase***
Building theoretical framework	Selection of the research sample	Descriptive statistics and exploratory measurement results	Initial generalization
Preparation of the initial questionnaire	Distribution of questionnaires	Analysis of open (qualitative) questions	Hypotheses development
Pilot studies	Collection and verification of the completeness of questionnaires	Analysis of clusters	Finally conclusions
Preparation of the final questionnaire		Comparative analysis	

Table. 3. Cronbach's alpha and reliability estimates

Construct	***Nr of items***	***Construct reliability***	***Cronbach's Alpha***
Opportunities	4	0.70	0.674
Threats	4	0.87	0.865
Risk	2	0.61	0.594
Efficiency	2	0.59	0.585
Concern	2	0.75	0.749
Intention	2	0.89	0.889

Table 4. Items, factor loadings and internal consistency measures

Construct	***Measurement item***	***Loading***	***% of Variance***
Opportunities	Increasing the organization's market opportunities.	0.87	14.556
	Reduction of costs (in long time).	0.82	
	Contributing to the environmental performance.	0.79	
	Improving the image of organization.	0.76	
Threats	Threat of losing market share.	0.872	8.318
	Threat to the image.	0.805	
	Threat to cooperation with suppliers.	0.439	
	Threat to cooperation with stakeholders.	0.837	
Risk	Financial risk.	0.694	9.388
	Implementation risk (organizational).	0.682	
Efficiency	Efficiency of reducing emissions.	0.911	7.459
	Efficiency in reducing energy consumption.	0.614	
Concern	Consequences of the lack of implementation for organization.	0.672	9.342
	Consequences of the lack of implementation for society.	0.550	
Intention	Readiness to implement process innovations.	0.886	11.203
	Readiness to implement product innovations.	0.793	

3.6. Analysis of results

For the results analysis, the LIWC program was applied to analyze texts with the calculation method. One of the main benefits of using LIWC is that the program has standardized dictionaries that have been developed over several years. LIWC program allows for an accurate identification of words referring to emotions, hence its usefulness in respect of values and ethical issues. Our focus was, in particular, on several word categories: positive and negative emotions. The program made it possible to calculate automatically the prevalence of words in a given category.

The analysis of clusters was used, grouping companies by their interpretation of innovation. The assignment of firms to clusters was done using the k-means cluster optimization technique, where dissimilarity from each other and from cluster averages was the decision criterion. To create a number of clusters (groups of similar objects), Pseudo F procedure was applied. Grouping was stopped after finding local maxima. High values of these statistics indicate high differentiation between the clusters (Calinski and Harabasz, 1974; Everitt et al., 2001). The analysis of clusters was performed using SPSS software.

4. Results

4.1. General research findings

Nearly a half, as 49% respondents, confirmed that they consider climate-related innovation as an ethical problem. The opposite view was held by 29% of the respondents (20% had no opinion) The reasons for ethical perception were as follows: a) a moral duty to mitigate damage brought about by climate change caused by man (37%), b) a duty to protect others from threats (20%). The respondents, therefore, associate this perspective with moral duties or obligations. Other values associated with climate-related innovation were: fairness (19%), equality (15%), preventing evil (preventing damage) 18%, importance for others (15%), integrity (8%), honesty (10%), lucidity (5%), or openness (5%). In the case of the other group (no association with ethics) the following were indicated: a) technical or environmental nature of the problem of climate change and expectations for solutions of this kind - anthropogenic or natural - (28%), b) no confidence that the problem of climate change exists or that it can be solved through innovation (25%), c) no connection between ethics with climate change (15%), d) ignorance of ethical issues (10%). Over a half of the surveyed did not answer the open-ended question. The results obtained with respect to associating ethical aspects with climate-related innovation are convergent with individual views on desirability of mitigating the impacts of climate change. 55% of the respondents believe it is their obligation to take such actions. 60% of them see innovation in terms of opportunities (definitely yes or rather yes), with 35% holding the opposite opinions. In the whole population the average value obtained for opportunities was 3.6 (on a scale1-5), while for threats, the value obtained was 2.9. These results show perception of innovation more through market opportunities than threats. Therefore, organizations view climate-related innovation similarly to other kinds of commercial innovation which may appear profitable.

The majority of respondents gave moderate evaluations for the efficiency of climate-related innovation. 55% of the respondents perceive it as partly effective, while 30% think the opposite. The stratification of the answers is evident for 'concern'. Negative effects of the lack of innovation are noted by 60% of the respondents (answers: 'serious' or 'very serious problem'), 20% referred to it as moderate (somewhat) or as not very serious (20%). Therefore, two thirds of the surveyed are aware of the negative consequences of the lack of climate-related innovation.

4.2. Cluster analysis

To determine associations between perceiving climate-related innovation with the selected variables, they were collated into the following groups: ethical (those having an ethical dimension), unethical, other answers (Table 5).

While comparing an ‘ethical’ and ‘unethical’ group, one should confirm that the group 'ethical' perceives innovation more through opportunities. Market threats it generates are regarded as of minor importance. Contrary to this, the group 'unethical' perceives a greater threat from this kind of innovation. Moderate answers were provided by the respondents who are not convinced of an ethical dimension of climate-related innovation or it lacks.

The results obtained indicate that persons perceiving innovation as ethical are characterized by a greater concern for climate. In this group, perception of lower implementation risk and higher efficiency of implemented innovation were also noted. The remaining groups evaluate the consequences of not undertaking climate-related innovation at a similar level (2.5). Interestingly enough, the undecided respondents perceive efficiency of this kind of innovation as lower (1.65) compared with the respondents who do not see any ethical aspect (1.89). That means that in their opinion, the issue of solution efficiency is not connected with an ethical dimension. It is may result from adopting a quantitative approach to the evaluation of the results and identifying significant goals for innovation. Other groups evaluated efficiency at a similar level. The balance refers to the fact that scores in the ‘ethical’ and ‘unethical’ groups are similar.

A further analysis of innovation as an ethical issue indicates that proponents of this approach point at a moral obligation to minimize losses by man.

Table 5. Results of the cluster analysis; a breakdown by perceptions of ethical dimension

Measures	*Ethical*	*Unethical*	*Other answers (Not sure)*	*F*	*p*
Opportunities	3.28	2.64	2.53	5.03	<0.01
Threats	1.73	2.09	1.92	1.4	<0.01
Risk	2.49	2.58	1.84	5.38	<0.01
Efficiency	1.95	1.89	1.65	1.4	<0.01
Concern	3.03	2.53	2.5	2.12	<0.01

Thus, their approach to technology is affected by their personal system of values, a duty of responsibility and compensation, in particular. These results are consistent with the observations by Markowitz (2012), who points out that there is a link between the etiology of the problem and the issue of liability. The sense of moral obligation to respond depends on how we perceive the problem of climate change. The issue of perception is also relevant to taking personal responsibility for solving the problem.

4.3. Comparative analysis – high and low emission sectors

For the purpose of a more detailed analysis, the results were set for companies ranging from low to high emitters (Table 6). The sectors of high emission (with the highest rate of energy consumption) include electricity and heat production (25% of global greenhouse gas emissions) as well as steel, chemical, mineral and paper industries - 21% of global greenhouse gas emissions (Global Emissions).

In companies with low emission sectors, climate change is interpreted as generating general social risk or risk connected with the loss of goodwill. According to one of the respondents, 'climate change is not going to have effect on the company in the near future.' Companies in these sectors focus rather on current operations, without recognizing the role of the long-term effects of climate change. This indicates a short-term orientation, in which innovation is seen through the lens of the threat (2.95) rather than the opportunity it creates (2.65). As companies less frequently, compared with high emission sectors, implement innovation, they determine identify risk as lower. More ethical companies in this group go beyond an internal, short-term focus. They take a responsible attitude towards society. It is manifested by their interest in the issue of innovation reducing emissions and showing greater concern for its lack. Opportunities connected with innovation are referred to operational opportunities including improving energy efficiency. Some respondents pointed at the opportunity to perform a new role as a source of financing innovation for companies of higher emission.

In the group of companies from sectors of higher emission, climate-related innovation is identified as a threat rather than an opportunity. The respondents associate such a threat with the necessity to incur ongoing capital expenditure on modernization in order to reduce a volume of emission. They assess implementation risk at the level similar to that one pointed by the respondents from other sectors. The respondents in this group, however, care more about the effects of not taking activities aimed at the climate protection. They more often indicate ethical values associated with climate-related innovation: fairness, concerns for contemporary and future generations, shared responsibility, prevention, equality, health, well-being; they perceive associations of innovation with ethics to a greater extent. o a greater extent (65%).

4.4. Mechanisms relating perception of innovation to its implementation

The results obtained have their implications for further research into the ethics of climate change. Perceiving climate-related innovation as having an ethical dimension affects directly the willingness to implement it. While considering which mechanisms link perceiving innovation with its implementation, we find that moral obligations are of indirect nature (in this relationship). They arise from the internal duty owed by managers, an obligation to take actions – so from the moral code. Motivation has an internal dimension here. It is confirmed by earlier studies (Hunt and Vittel, 1986; Koçyiğit and Karadağ, 2016), where ethical perception is a function of an individual's value/belief system. Therefore, we believe that individual's ethical judgments of innovation are a function of his/her ethical evaluations based on moral philosophies. The other factor of mediation nature is seeking for social legitimacy through underlying benefits from innovation for the society. This factor refers to encouraging activities of high social importance, being both preventive and remedial (Heckler and Ronquillo, 2020). Climate-related innovation allows to win social acceptance thanks to positive (desirable) effects.

The above discussion draws attention to two ethical principles of mechanisms combining perception and implementation of climate-related innovation: deontological and teleological (Fig. 2).

At the center of a deontological approach, there are principles of justice, basic rights, duties, obligations, responsibilities, proper conduct, and inherent natural rights of others. Reliance on a deontological judgement process requires that a decision-maker takes actions which "… are best judged as good, standing alone and without regard to the consequences" and that these "… actions are correct in and of themselves because they stem from fundamental obligations" (Akaah, 1997; Laczniak and

Murphy, 1993). Individual moral obligations indicating what is good, proper, fair have a positive effect on the interpretation of climate-related innovation which is viewed as obligation. Thereby, it goes in line with deontological ethics.

In contrast, a teleological approach centers on the consequences of a behavior. A teleological judgement has as its cornerstone "… the relative amount of goodness or badness of the consequences of a behavior" (Hunt and Vasquez-Parraga, 1993). The teleological aspects of environmental protection are discussed in studies of a religious nature and related to them (Holy Father Francis, 2015; Sachs, 2016). They indicate the need for dialogue on environment in international politics, transparency in decision-making processes, building education and ecological spirituality. As far as technical innovations are concerned, they point out that profitability can't be the only evaluation criteria. Agreeing with this statement we assume that teleological judgement of climate-related innovation lies in assessing its consequences and looking for a social legitimacy thanks to emphasizing positive effects. Interest in innovation is appropriate because it creates the greatest good for the highest number of individuals (it is consistent with utilitarianism).

4.5. Formulation of hypotheses

Perception of the issue of climate change from a long-term perspective draws attention to threats connected with it as well as its complexity. An ethical aspect of climate-related innovation is evident, first of all, in their relation to values/moral obligations and looking for social legitimacy because of its implementation. Introducing climate-related innovation allows to maintain compliance with an internal system of values (internal stimuli) and social expectations (external needs). These two mechanisms have the potential to activate broader search for innovations. Of great importance for interpretation of innovation is evaluation of opportunities, threats and risks connected with it.

This interpretation may lead to initiating an implementation process or its postponement. A change in perception of innovation may occur through acquiring knowledge. Learning influences, e.g. a better understanding threats generated by the climate change, and thus, it also influences changes in interpretation of innovation.

From an individual perspective, perception of the climate change in an ethical dimension encourages managers to undertake actions reducing effects of such changes. A scope of these activities would vary depending on characteristics of particular solutions. Differences in activities/behaviors among managers may be traced, in part, to differences in interpretive sets. In a deontological judgment process, an individual assesses the inherent equity or incompatibility of the innovation according to their own system of values and knowledge.

Table 6. Results by low and high emission sectors

Measures	***Low emission***	***High emission***	***F***	***P***
Opportunities	2.65	2.73	1.04	<0.01
Threats	2.95	2.86	0.94	<0.01
Risk	2.65	2.7	0.08	<0.01
Efficiency	2.25	1.26	44.16	<0.01
Concern	2.51	2.93	3.08	<0.01

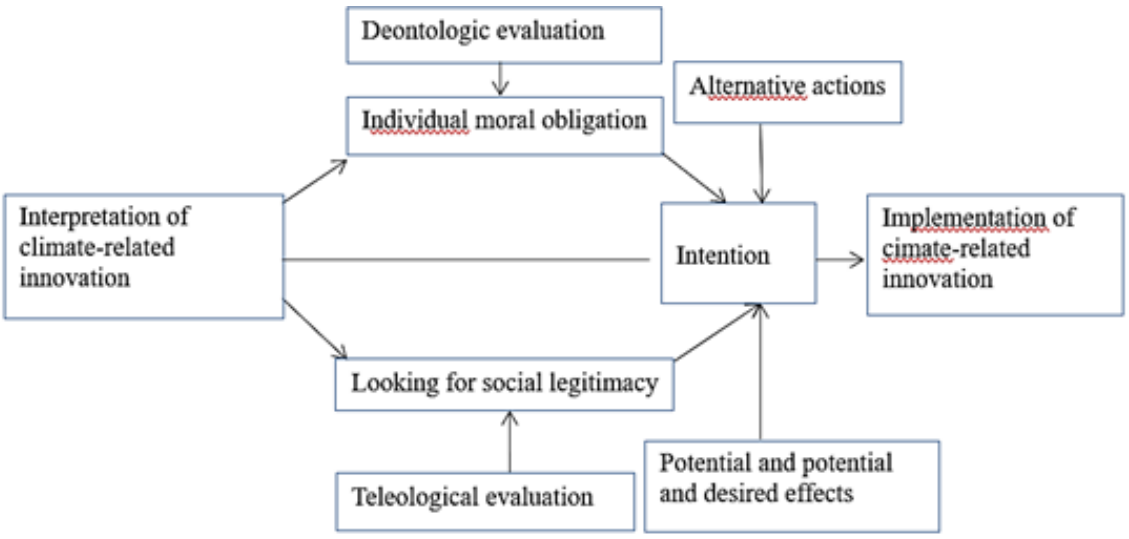

Fig. 2. Influence of interpretation of climate-related innovation on its implementation

The teleological judgement the process focuses on the probability and possible effects of innovation on stakeholders and the importance of a particular stakeholder group. It means evaluation of climate-related innovation in terms of its effects and importance for stakeholders. Ethical innovation assessment is a function of individual's deontological and teleological evaluation. That is, EJ = f(DE, TE), where EJ is ethical judgments, DE is deontological judgement and TE is teleological judgement. We advance that.

Hypothesis 1: The ethical perception of climate-related innovation depends on deontological and teleological judgement.

Ethical judgement may lead to implementation of innovation or its postponement. It arises from the fact that ethical judgments affect intentions independently. Managers may view the climate change as an ethical issue but not undertake climate-related innovation due to their negative interpretations. If innovation is not to be treated as a tool significantly reducing negative impacts of the organization's activities on the climate, there will not appear any intention to implement it or choose other solutions. Therefore:

Hypothesis 2: Ethical judgement affects implementation of climate-related innovation through the intervening variable of intentions.

This hypothesis is consistent with a theory of normative ethics (Benlahcene et al., 2018). Its objective is to increase our understanding of ethical decision making by means of a process theory that explains and predicts phenomena in situations having ethical content.

5. Conclusions

The present research examined managers' perception of climate-related innovation. The results raise awareness of the perception of innovation in an ethical dimension. A deeper understanding of how managers think climate change can improve the process of implementing climate-related innovation on a broader scale.

Although the empirical results reflect the beliefs of a very specific subset of employees, the results have important implications for management of climate-related innovations. Due to belief that climate change does not occur or causes only environmental effects, about 30% of the surveyed managers do not see the ethical dimension of climate related innovations. Interestingly enough, managers' beliefs are not reflected in evaluation of innovation effectiveness, which got similar assessments from both groups. Differences occur in the assessment of opportunities/threats connected with this kind of innovation. Thereby, an ethical interpretation of climate change innovation is connected with the assessment of market benefits and threats. Taking into account a sector analysis, the research findings show that sectors of high emission see more opportunities of innovation. It results from the fact that in this group, clean technologies are the most common type of implemented solutions, hence, they do not overestimate either risks or threats of their implementation. However, effectiveness of climate-related innovation is evaluated noticeably lower, than in the case of organizations from low emission sectors. It contrasts with the results of analyses indicating effectiveness of clean technologies also in the sectors of high emission (Worrell et al., 2001a; Worrell et al., 2001b).

The results confirm the causal link between the perception of the causes of climate change and the motivation to respond The results indicate that the respondents who see an ethical dimension of climate-related innovation, link it with moral obligations to minimize damage caused by man, or with obligations of the organization towards the society. Other ethical values which associated with climate-related innovation were justice, equality, preventing evil (damage), importance for others. We suggest that those who identify climate-related innovation as a moral imperative also deeper engage in their implementation. That is confirmed by the answers referring to impacts of the lack of activities and it proves that individual, ethical interpretation of innovation is associated with a concern for mitigating climate change.

The research carried out prove the need for a deontological and teleological judgement of climate-related innovation. Interpretation of innovation is dependent on the perception of climate change per se, initial evaluation in terms of opportunities, risks, threats and perception of the effects where there is a lack of such. The interpretation activates two ethical mechanisms: moral obligation and social legitimacy. Both mechanisms have the potential to activate broader search for innovation.

For managers, the results highlight how interpretation of innovation may influence the interest in it. They indicate the significance of interpretation of climate change as an ethical issue. This, in turn, determines the perception of the need for taking activities in response. Secondly, the results underline the need for sharing information on the effectiveness of innovation, opportunities, and risks connected with it. Transfer of climate-related innovation requires communication about climate change as well as specification of adaptive solutions. And thirdly, it is important that we talk about social obligations of organizations.

Current research is limited in many respects. Firstly, by selecting respondents only from proecological organizations, which may affect their beliefs. Future research should include non-ecologically oriented entities. It would be fairly interesting to carry out a comparative study on

organizations implementing or not implementing eco-innovation. In addition, the study omitted a number of ethical issues, i.e. environmental and intergenerational justice, the system of individual values. The economic efficiency aspect of innovation has been taken into account quite generally. Future research should attempt to employ even more robust measures, especially with respect to moral and economic issues.

Further research may take into account the recent insights in the field of moral psychology in order to better explain the etiology of beliefs in innovation, the analysis of barriers and stimuli as a moral imperative. In order to enhance theoretical understanding of the importance of ethical interpretation of innovations so that they might be implemented, it would be desirable to test the proposals that combine an ethical judgement of innovation with implementing through ethical mechanisms using a large sample of organizations. This would help to clarify the size and the direction of the effects.

References

Akaah I.P., (1997), Influence of deontological and teleological factors on research ethics evaluations, *Journal of Business Research*, **39**, 71-80.

Arbuckle Jr.J.G., Morton L.W., Hobbs J., (2013), Understanding farmer perspectives on climate change adaptation and mitigation: The roles of trust in sources of climate information, climate change beliefs, and perceived risk, *Environment and Behavior*, **42**, 205-234.

Arundel A., Kemp R., (2009), *Measuring eco-innovation*, Working paper UNU-MERIT, Maastricht 17, On line at: https://www.oecd.org/greengrowth/consumption-innovation/43960846.pdf

Bartoszczuk P., (2018), The risk in eco-innovation introduction at the enterprises, *International Journal of Data Analysis Techniques and Strategies*, **10**, 257-272.

Baumane-Vitolinaa I., Calsa I., Sumilo E., (2016), Is ethics rational? Teleological, deontological and virtue ethics theories reconciled in the context of traditional economic decision making, *Procedia Economics and Finance*, **39**, 108-114.

Benlahcene A., Zainuddin R.B., Ismail N.S.A., (2018), A narrative review of ethics theories: teleological &deontological ethics, *IOSR Journal of Humanities and Social Science*, **23**, 31-38.

Besio C., Pronzini A., (2014), Morality, ethics, and values outside and inside organizations: an example of the discourse on climate change, *Journal of Business Ethics*, **119**, 287-300.

Bitat A., (2012), *Impact of Eco-innovation on Firms' Competitiveness. An Empirical Study based on Mannheim Innovation Panel*, College of Europe, On line at https://www.coleurope.eu/impact-eco-innovation-firms-competitiveness-empirical-study-based-mannheim-innovation-panel

Blok V., Tempels T., Pietersma E., Jansen L., (2017), *Exploring Ethical Decision Making in Responsible Innovation: The Case of Innovations for Healthy Food*, In: *Responsible Innovation 3*, Asveld L., van Dam-Mieras R., Swierstra T., Lavrijssen S., Linse K. (Eds.), Springer International Publishing, Cham, Switzerland, 209-230.

Bosetti V., Carraro C., Duval R., Tavoni M., (2011), What should we expect from innovation? A model-based assessment of the environmental and mitigation cost implications of climate-related R&D, *Energy Economics*, **33**, 1313-1320.

Bosetti V., Carraro C., Massetti E., Tavoni M., (2014), *Climate Change Mitigation, Technological Innovation and Adaptation: A New Perspective on Climate Policy*, Northampton, Edward Elgar.

Broome J., (2008), The ethics of climate change: Pay now or pay more later?, *Scientific American*, **298**, 96-102.

Brown D.A., Taylor P., (2014), *Ethics and Climate Change*, A Study of National Commitments IUCN, Gland, Switzerland, On line at: https://ethicsandclimate.org/.

Burget M., Bardone E., Pedaste M., (2017), Definitions and conceptual dimensions of responsible research and innovation: A literature review, *Science and Engineering Ethics*, **23**, 1-19.

Calinski T., Harabasz J., (1974), A dendrite method for cluster analysis, *Communications in Statistics*, **3**, 1-27.

Capstick S., Whitmarsh L., Poortinga W., Pidgeon N., Upham P., (2015), International trend in public opinion of climate change over the quarter past century, *WIRE climate change*, **6**, 35-61.

Carroll A.B., (1983), Corporate social responsibility: Will industry respond to cutbacks in social program funding, *Vital Speeches of the Day*, **49**, 604-608.

Cervantes M., Žarnic Z., Copeland H., (2018), *Accelerating the development and diffusion of low-emissions innovations*, 37th Round Table on Sustainable Development, OECD Headquarters, Paris.

Charter M., Clark T., (2007), *Sustainable Innovation*, The Centre for Sustainable Design, Farnham, UK.

Choi H., Jang J., Kandampully J., (2015), Application of the extended VBN theory to understand consumers' decisions about green hotels, *International Journal Hospitality Management*, **51**, 87-95.

Comest, (2010), *The ethical implication of global climate change*, Report, World Commission on the ethics of scientific knowledge and technology, France.

Costa-Campi M.T., Duch Brown N., Quevedo J.G., (2014), R&D drivers and obstacles to innovation in the energy industry, *Energy Economics*, **46**, 20-30.

De Coninck H., Sagar A., (2015), Making sense of policy for climate technology development and transfer, *Climate Policy*, 15, 1-11,

Dechezleprêtre A., Glachant M., Ménière Y., (2008), The Clean Development Mechanism and the international diffusion of technologies: An empirical study, *Energy Policy*, **36**, 1273-1283.

Doherty T.J., Clayton S., (2011), The psychological impacts of global climate change, *American Psychologist*, **66**, 265-276.

Dong Y., Wang X., Jin J., Qiao Y., Shi L., (2014), Effects of eco-innovation typology on its performance: empirical evidence from Chinese enterprises, *Journal of Engineering and Technology Management*, **34**, 78-98.

Dutton J.E., Jackson S.E., (1987), Categorizing strategic issues: Links to organizational action, *The Academy of Management Review*, **12**, 76-90.

Eckman R.S., Stackhouse Jr. P.W., (2012), CEOS contributions to informing energy management and policy decision making using space-based Earth observations, *Applied Energy*, **90**, 206-10.

Engels A., Huether O., Schaefer M., Held H., (2013), Public climate-change skepticism, energy preferences and political participation, *Global Environmental Change*, **23**, 1018-1027.

European Economic and Social Committee (EESC), (2016), *Summary of the Conference "RRI Shaping New Horizons: Responsible Research and Innovation in Europe and across the World*, On line at: http://www.eesc.europa.eu/sites/default/files/resources/docs/summary-from-the-conference-for-the-website-apres-relecture.pdf.

Everitt B.S., Landau E., Leese M., (2001), *Cluster Analysis*, Arnold, London.

Ferguson M.A., Branscombe N.R., (2010), Collective guilt mediates the effect beliefs about global warming on willingness to engage in mitigation behavior, *Journal of Environmental Psychology*, **30**, 135-142.

Fussel H.M., (2009), *The Ethical Dilemma of Climate Change: How Unequal is the Global Distribution of Responsibility for and Vulnerability to Climate Change?*, IOP Conf. Series: Earth and Environmental Science, 6, 1-2, On line at: https://iopscience.iop.org/article/10.1088/1755-1307/6/11/112013/pdf

García J.LS., Sanz J.M.D., (2018), Climate change, ethics and sustainability: An innovative approach, *Journal of Innovation and Knowledge*, **3**, 70-75.

Gardiner S.M., (2004), Ethics and global climate change, *An International Journal of Social, Political, and Legal Philosophy*, **114**, 555-600.

Gardiner S.M., (2006), A perfect moral storm: climate change, intergenerational ethics and the problem of moral corruption, *Environmental Value*, **15**, 397-413.

Gardiner S.M., (2011), *Climate Justice*, *The Oxford Handbook of Climate Change and Society*, Schlosberg D., Norgaard R.B., Dryzek J.S. (Eds.), Oxford University Press, Oxford, 309-322.

Ghazali E.M., Nguyen B., Mutum D.S., Yap S.F., (2019), Pro-Environmental behaviours and value-belief-norm theory: assessing unobserved heterogeneity of two ethnic groups, *Sustainability*, **11**, 3237, https://doi.org/10.3390/su11123237

Ghisetti C., Rennings K., (2014), Environmental innovations and profitability: How does it pay to be green? An empirical analysis on the German innovation survey, *Journal of Cleaner Production*, **75**, 106-117.

Gkargkavouzi A., Halkos G., Matsiori S., (2019), Environmental behavior in a private-sphere context: Integrating theories of planned behavior and value belief norm, self-identity and habit, *Resources, Conservation and Recycling*, **148**, 145-156.

Grunwald A., (2011), Responsible innovation: bringing together technology assessment, applied ethics and STS research, *Enterprise and Work Innovation Studies*, **7**, 9-31.

Haney A.B., (2017), Threat interpretation and innovation in the context of climate change: An ethical perspective, *Journal of Business Ethics*, **143**, 261-276.

Hair Jr. J.F., Black W.C., Babin B.J., Anderson R.E., (2010), *Multivariate Data Analysis*, 7th Edition, Pearson Prentice Hall, London.

Han H., (2015), Travelers' pro-environmental behavior in a green lodging context: converging value-belief-norm theory and the theory of planned behaviour, *Tourism Management*, **47**,164-177.

Harmon R.R., Cowan K.R., (2009), A multiple perspectives view of the market case for green energy, *Technological Forecasting and Social Change*, **76**, 204-13.

Harris P.G., (2011), *Reconceptualizing global governance*, D. Schlosberg, R.B. Norgaard, J.S. Dryzek (Eds.), In: *The Oxford Handbook of Climate Change and Society*, Oxford University Press, Oxford, 639-652.

Harvey Nash Board Report, (2020), *Predicting the unpredictable*, On line at: https://static1.squarespace.com/static/5dd4f8270fb5a0308e79b424/t/5e53e254169a2139bbbc439e/1582555749350/AlumniHarveynashBoardResearch.pdf.

Haselip J.A., Hansen U.E., Puig D., Trærup S.L.M., Dhar S., (2015), Governance, enabling frameworks and policies for the transfer and diffusion of low carbon and climate adaptation technologies in developing countries, *Climatic Change*, **131**, 363-370.

Heckler N., Ronquillo J.C., (2020), Effective resolution of ethical dilemmas in social enterprise organizations: A moral philosophy and public management approach, *Public Integrity*, **22**, 39-53.

Hoggett R., (2014), Technology scale and supply chains in a secure, affordable and low carbon energy transition, *Applied Energy*, **123**, 296-306.

Holy Father Francis, (2015), *Encyclical Letter Laudato Si' on Care for our Common Home*, Rome, On line at: http://w2.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco20150524enciclica-laudato-si.htm.

Hou T.C.T., (2019), The relationship between corporate social responsibility and sustainable financial performance: firm-level evidence from Taiwan, *Corporate Social Responsibility and Environmental Management*, **26,** 19-28.

Hunt S.D., Vitell S., (1986), A general theory of marketing ethics, *Journal of Macromarketing*, **8**, 5-16.

Hunt S.D., Vasquez-Parraga A.Z., (1993), Organizational consequences, marketing ethics, and salesforce supervision, *Journal of Marketing Research*, **30**, 78-90.

Johnstone N., Pilat D., (2015), Business innovation and climate change: Policy makers must favour dynamism, OECD Observer, 304, November, On line at: https://www.oecd-ilibrary.org/docserver/observer-v2015-3-en.pdf?expires=1632566571&id=id&accname=guest&checksum=88460A1C7E7255503A354F8D8D06641F

Johnstone N., Hašcic I., Popp D., (2010), Renewable energy policies and technological innovation: evidence based on patent counts, *Environmental and Resource Economics*, **45**, 133-55.

Jones C., Lenart M., (2014). Forestry professionals and extension educators vs. climate change: implications for cooperative extension programming, *Journal of Extension*, **52**, 1-14.

Kemp R., Pearson P., (2007), *Final Report MEI Project about Measuring Eco-Innovation*, UMMERIT, Maastricht, The Netherlands, On line at: https://www.oecd.org/env/consumption-innovation/43960830.pdf

Khalid K., Eldakak S.E., Loke S.P., (2017), A structural approach to ethical reasoning: the integration of moral philosophy, *Electronic Business Journal*, **16**, 453-472.

Knowledge & Wharton, (2017), *How business can take the lead on combating climate change*, Wharton University of Pennsylvania, On line at https://knowledge.wharton.upenn.edu/article/business-can-take-lead-combatting-climate-change/

Koçyiğit M., Karadağ E., (2016), Developing an Ethical Tendencies Scale based on the theories of ethics, *Turkish Journal of Business Ethics*, **9**, 297-307.

Kolk A., (2013), The Role of International Business in Clean Technology Transfer and Development. Climate Policy, On line at http://dx.doi.org/10.1080/14693062.2013.772357

Koops B.J, Oosterlaken I., Romijn H., Swierstra T., van den Hoven J., (2015), *Responsible Innovation 2 - Concepts, Approaches, and Applications*, London, Springer.

Koufteros X.A., (1999), Testing a model of pull production: a paradigm for manufacturing research using structural equation modelling, *Journal Operational Management*, **17**, 467-488.

Kraus S., Rehman S.U, García F.J.S., (2020), Corporate social responsibility and environmental performance: The mediating role of environmental strategy and green innovation, *Technological Forecasting and Social Change*, **160**, 120262, https://doi.org/10.1016/j.techfore.2020.120262

Lacey J., Howden‐S.M., Cvitanovic Ch., Dowd A.M, (2015), Informed adaptation: Ethical considerations for adaptation researchers and decision-makers, *Global Environmental Change*, **32**, 200-210.

Laczniak G.R., Murphy P.E., (1993), *Ethical Marketing Decisions: The Higher Road*, Allyn and Bacon, Boston, MA.

Lema A., Lema R., (2013), Technology transfer in the clean development mechanism: Insights from wind power, *Global Environmental Change*, **23**, 301-313.

Lema R., Johnson B., Andersen A.D., Lundvall B.A., Chaudhary A., (2014), *Low-Carbon Innovation and Development*, Aalborg University Press, Aalborg, Denmark.

Long G., (2011), Disagreement and responses to climate change, *Environmental Values*, **20**, 503-525.

Lorenzoni I., Nicholson-Cole S., Whitmarsh S., (2007), Barriers perceived to engaging with climate change among the UK public and their policy implications, *Global Environmental Change*, **17**, 445-459.

Markowitz E.M., (2012), Is climate change an ethical issue? Examining young adults' beliefs about climate and morality, *Climatic Change*, **114**, 479-495.

Martinuzzi A., Blok V., Brem A., Stahl B., Schönherr N., (2018), Responsible research and innovation in industry-challenges, insights and perspectives, *Sustainability*, **10**, 702, https://doi.org/10.3390/su10030702

McJeon H.C., Clarke L., Kyle P., Wise M., Hackbarth A., Bryant B.P., (2011), Technology interactions among low-carbon energy technologies: what can we learn from a large number of scenarios?, *Energy Economics*, **33**, 619-31.

McWilliams A., Siegel D., (2000), Corporate social responsibility and financial performance: correlation or misspecification?, *Strategic Management Journal*, **21**, 603-609.

Mensah C.N., Long X., Boamah K.B., (2018), The effect of innovation on CO_2 emissions of OCED countries from 1990 to 2014, *Environmental Science and Pollution Research*, **25**, 29678-29698.

Nathan G., (2010), *Social Freedom in a Multicultural State: Towards a Theory of Intercultural Justice*, Palgrave Macmillan, London, UK.

Nathan G., (2015), Innovation process and ethics in technology: an approach to ethical (responsible) innovation governance, *Journal on Chain and Network Science*, **15**, 119-134.

Neale E.P., Tran G., Brown R.C., (2020), Barriers and facilitators to nut consumption: a narrative review, *International Journal of Environmental Research and Public Health*, **17**, 9127, http://doi.org/10.3390/ijerph17239127

Neto A.S., Jabbour C.J.C., Jabbour A. B.L., (2014), Green training supporting eco-innovation in three Brazilian companies: practices and levels of integration, *Industrial and Commercial Training*, **46**, 387-392.

Nicolaides A., (2017), Ethical practices, eco-centric business and environmental sustainability, *Journal of Human Ecology*, **57**, 1-10.

Nordlander A., (2021), Green purpose: Teleology, ecological ethics, and the recovery of contemplation, *Studies in Christian Ethics*, **34**, 36-55.

Nuttall W.J., Manz D.L., (2008), A new energy security paradigm for the twenty-first century, *Technological Forecasting and Social Change*, **75**, 1247-1259.

Oreg S., Katz-Gerro T., (2006), Predicting proenvironmental behavior cross-nationally: Values, the theory of planned behavior, and value-belief-norm theory, *Environmental and Behavior*, **38**, 462-483.

Owen R., Macnaghten P., Stilgoe J., Gorman M., Fisher E., Guston D., (2013), *A Framework for Responsible Innovation*, Owen R., Bessant J., Heintz M. (Eds.), In: *Responsible Innovation. Managing the Responsible Emergence of Science and Innovation in Society*, John Wiley Ltd, London, UK, 27-50.

Palma D., Coletta G., (2011), Renewables technological competitiveness and sustainable development in the new global economy, ENEA Technology Transfer Unit.

Pavie X., Scholten V., Carthy D., (2014), Responsible innovation: From concept to practice, *World Scientific*, Singapore.

Pellé S., Reber B., (2015), Responsible innovation in the light of moral responsibility, *Journal on Chain and Network Science*, **15**, 107-117.

Pellé S., Reber B., (2016), *From Ethics in Research to Responsible Innovation* (in French), ISTE Editions, London, UK.

Peng X., Liu Y., (2016), Behind eco-innovation: Managerial environmental awareness and external resource acquisition, *Journal of Cleaner Production*, **139**, 347-360.

Podsakoff P.M., MacKenzie S.B., Jeong-Yeon L., Podsakoff N.P., (2003), Common method biases in behavioral research: A critical review of the literature and recommended remedies, *Journal Applied Psychology*, **88**, 879-903.

Ramanathan V., (2014), *The Two Worlds Approach for Mitigating Air Pollution and Climate Change*, In: *Pontificiae Academiae Scientiarum Socialivm, Sustainable Humanity, Sustainable Nature, our Responsibility*, Dasgupta P.S., Ramanathan V., Sorondo M.S. (Eds.), Vatican, 285-300.

Rennings K., (2000), Redefining innovation – eco-innovation research and the contribution fromecological economics, *Ecological Economics*, **32**, 319-332.

Rennings K., Zwick T., (2003), *Employment Impacts of Cleaner Production*, ZEW Economic Studies, Heidelberg.

Rodriguez-Franco C., Haan T.J., 2015, Understanding climate change perceptions, attitudes, and needs of forest service resource managers, *Journal of Sustainable Forestry*, **34**, 423-444.

Rogers E.M., (2003), *Diffusion of Innovations*, 5th Edition, Free Press, New York.

Rosen-Zvi I., (2011), You are too soft!: What can corporate social responsibility do for climate change?, *Minnesota Journal of Law, Science and Technology*, **527**, 531-32.

Sachs J., (2016), *The Radical Vision of Laudato si'. Laudato si' and the Path to COP22*, Proc. of the Joint Seminar of the Pontifical Council for Justice and Peace and the Pontifical Academy of Sciences, Vatican City, On line at: http://www.casinapioiv.va/content/accademia/it/publications/scriptavaria/laudato_si_cop22.pdf

Scherer A.G., Palazzo G., (2011), The new political role of business in a globalized world: A review of a new

perspective on csr and its implications for the firm, governance, and democracy, *Journal of Management Studies*, **48**, 899-931.

Schiederig T., Tietze F., Herstatt C., (2012), Green innovation in technology and innovation management - An exploratory literature review, *R&D Management*, **42**, 180-192.

Schlaile M.P., Urmetzer S., Blok V., Andersen A.D., Timmermans J., Mueller M., Fagerberg J., Pyka A., (2017), Innovation systems for transformations towards sustainability? Taking the normative dimension seriously, *Sustainability*, **9**, 2253.

Schniederjans D., Schniederjans M., (2015), Quality management and innovation: new insights on a structural contingency framework, *International Journal Quality Innovation*, **1,** 1-20.

Schroeder H., Boykoff M.T., Spiers L., (2012), Equity and state representations in climate negotiations, *Nature Climate Change*, **2**, 834-836.

Seglin J.L., (2000), *The Good, the Bad, and Your Business: Choosing Right when Ethical Dilemmas Pull you Apart*, John Wiley and Sons Ltd., New York, USA.

Shang R.A., Chen Y.C., Chen D.C., (2008), Ethical decisions about sharing music files in the P2P environment, *Journal of Business Ethics*, **80**, 349-365.

Singer T., (2006), *The Neuronal Basis of Empathy and Fairness*, In: *Empathy and Fairness*, Bock G., Goode J. (Eds.), Novartis Foundation Symposia 278, Navartis Foundation.

Slovic P., Flynn J., Mertz C.K., Poumadère M., Mays C., (2000), *Nuclear and the Public: A Comparative Study of Risk Perception in France and the United States*, In: *Cross-cultural Risk Perception: A Survey of Empirical Studies*, Renn O., Rohrmann B. (Eds.), Kluwer Academic Press, Amsterdam.

Spence A., Venables D., Pidgeon N., Poortinga W., Demski C., (2010), *Public Perceptions of Climate Change and Energy Futures in Britain: Summary Findings of a Survey Conducted in January-March 2010*, Technical Report, Cardiff, School of Psychology.

Steentjes K., Pidgeon N., Poortinga W., Corner A., Arnold A., Böhm G., Mays C., Poumadère M., Ruddat M., Scheer D., Sonnberger M., Tvinnereim E., (2017), *European Perceptions of Climate Change: Topline Findings of a Survey Conducted in Four European Countries in 2016*, Cardiff University, UK.

Stilgoe J., Owen R., Macnaghten P., (2013), Developing a framework for responsible innovation, *Research Policy*, **42**, 1568-1580.

Stern P.C., Dietz T., Abel T., Guagnano G.A., Kalof L., (1999), A value-belief-norm theory of support for social movements: The case of environmentalism, *Human Ecology Review*, 6(2), 81-97.

Stern N., (2006), *Stern Review on the Economics of Climate Change*, HM Treasury, London.

Stern P.C., (2000), New environmental theories: Toward a coherent theory of environmentally significant behaviour, *Journal of Social Issues*, **56**, 407-424.

Swierstra T., Jelsma K., (2006), Responsibility without moralism in technoscientific design practice, *Science Technology and Human Values*, **31**, 309-332.

Todaro N.M., Testa F., Daddi T., Iraldo F., (2020), The influence of managers' awareness of climate change, perceived climate risk exposure and risk tolerance on the adoption of corporate responses to climate change, *Business Strategy & Environment*, **30**, 1232-1248.

Tvinnereim E., Ivarsflaten E., (2016), Fossil fuels, employment, and support for climate policies, *Energy Policy*, **96**, 364-371.

UN Report (1987), *Our Common Future*, UN Report by the World Commission on Environment and Development, On line at: http://www.un-documents.net/our-common-future.pdf.

van den Hoven J., (2013), *Value sensitive design and responsible innovation*, In: *Responsible Innovation: Managing the Responsible Emergence of Science and Innovation in Society*, Owen R., Bessant J., Heintz M. (Eds.), Wiley, West Sussex., 75-83.

van der Werff E., Steg L., (2016), The psychology of participation and interest in smart energy systems: comparing the value-belief-norm theory and the value-identity-personal norm model, *Energy Research and Social Science*, **22**, 107-114.

von Schomberg R., (2013), *A vision of responsible research and innovation*, In: *Responsible innovation: managing the responsible emergence of science and innovation in society*, Owen R., Bessant J., Heintz M. (Eds.), John Wiley & Sons, Ltd., Chichester, UK, 51-74.

Wang S., Fan J., Zhao D., Wang S., (2016), Regional innovation environment and innovation efficiency: the Chinese case, *Technology Analysis and Strategic Management*, **28**, 396-410.

Wickson F., Carew A.L., (2014), Quality criteria and indicators for responsible research and innovation: learning from transdisciplinarity, *Journal Responsible Innovations*, **1**, 254-273.

World Commission, (2010), *The Ethical Implications of Global Climate Change: Report by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST*), World Commission on the Ethics of Scientific Knowledge and Technology, (2010), SHS.2010/WS/1, UNESCO, On line at: https://unesdoc.unesco.org/ark:/48223/pf0000188198.

Worrell E., Price L., Martin N., Hendriks Ch., Ozawa Meida L., (2001a), Carbon dioxide emissions from the global cement industry, *Annual Review of Energy and the Environment*, **26**, 303-329.

Worrell E., Price L., Martin N., (2001b), Energy efficiency and carbon dioxide emissions reduction opportunities in the US iron and steel sector, *Energy*, **26**, 513-536.

Xue L., Ray G., Sambamurthy V., (2012), Efficiency or Innovation: How do the industry environments moderate the effects of firms' IT asset portfolios, *MIS Quarterly*, **36**, 509-528.

Zhou Y., Shu C., Jiang W., Gao S., (2019), Green management, firm innovations, and environmental turbulence, *Business Strategy and Environment*, **28**, 567-581.