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# Socioeconomic Paradigms and the Perception of System Risks: A Study of Attitudes towards Nuclear Power among Polish Business Students

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**Abstract:** Due to anticipated energy shortages and the need to achieve climate goals, there is an urgent requirement for transition towards a green, resilient system of energy provision. This transition is hampered because important players in energy markets (governments and oligopolies), while supporting large-scale solutions, avoid or block systemic changes. This rejection of systemic change is strengthened by the dominant social paradigm, which ignores systemic vulnerabilities, treating resources as solutions and the environment as a sink. In its turn, the dominant social paradigm is contested by the new ecological paradigm and by attitudes towards sustainable business practices. Understanding this framework may be relevant for identifying decision-makers' perception of system risk, and thus for supporting a transition towards a more decentralized and resilient energy supply. In this context, this paper presents an empirical study among Polish students of a business university (N = 393), trying to discover the relationship between the social paradigms, perceptions of environmental resources and sinks, and systemic risk in large-scale energy production (i.e., nuclear power plants). Although the explained variance is limited, results show that various elements of the dominant social paradigm are related to problem denial. Technological optimism and belief in markets are predictors of optimism about resource shortages and neglect of system risk. This optimism is counteracted by political liberalism, and respondent attitudes towards sustainable business practices. Belief in market forces has an ambivalent effect, tempering technological optimism regarding nuclear energy but also political acknowledgement of the limited resources and sink capacities of the environment. Although the influence of the dominant social paradigm on energy transition can be identified, the results may indicate a decline in belief in market forces and liberal democracy, implying a rethinking of the dominant social paradigm may be needed. The existing relationship between these aspects warrants a critical review and discussion of the central role of the dominant paradigm in current management training. The results indicate that a lack of political liberalism and a negative attitude towards sustainable business practices amplify system risks in, e.g., large-scale nuclear energy projects.

**Keywords:** decision-making under risk; uncertainty; information; knowledge; cognitive factors in decision-making; energy markets; sustainable development; dominant social paradigm; new ecological paradigm



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## 1. Introduction

The need for a global energy transition to combat climate change is acknowledged in the UN's Earth Summit and Kyoto Protocol [1,2]. The COVID-19 pandemic stressed the urgency for this transition by showing the vulnerability of the global energy supply [3].

Global energy supply chains are stretched to the limit, which increases the impact of any disruptions [4,5]. The energy transition required to combat climate change is characterized by complexity, uncertainty, and many unknowns [6] including rebound effects leading to increased resource use [7]. Transition away from fossil fuels faces many barriers [8] and may increase instability in the energy supply due to, e.g., dependence on weather conditions and the lack of storage capacity [9]. While renewables (solar, wind) are preferred options [10,11], these solutions may be costly and slow [12,13]. Renewables themselves are a complex matter, where the transition is complex, and is often postponed for several reasons [14–18]. From a managerial point of view it seems attractive to introduce incremental changes in the existing supply structures because the investment outlays are lower, and the outcomes predictable, in contrast to the uncertain outcomes of an expensive and complex energy transition [19,20]. However, with climate change there is more at stake than just managerial prudence.

Following Habermas [21], it can be stated that every technology represents an ideology, and conversely each ideology supports and propagates its own technology [22]. Any new technology that departs from established systems of production and opens up new linkages to markets and to users is an architectural innovation, requiring a unique managerial climate and firms whose organizational structure is not bureaucratic and rigid [23] (p. 7). The transition to sustainable energy entails radical transformations in technologies, as well as in the structure of institutional, economic, and social relationships, and in the values and goals that define and guide social behavior [24]. Transition towards renewable energy therefore requires a socio-technical agenda that incorporates the economic, social, and political dimensions of a restructuring of the energy market [25–29]. Renewable energy sources may contribute not only to mitigation of global climate change but also facilitate energy independence [30]. This independence not only refers to geopolitical relations and domestic sources of energy [31], but may eventually imply independence of oligopolist/monopolist providers and result in (communal) self-sufficiency. Energy independence and off-grid solutions could empower households and local communities at the expense of central governments and existing supply or infrastructure monopolies/oligopolies. The upcoming transition to sustainable energy based on renewables entails a transition from current centralized energy systems to more decentralized ones [32]. However, vested interests in the oligopolistic energy markets create a lock-in [33,34], because the interests of these substantial stakeholders in society seem incompatible with the need for a global energy transition [35] (pp. 387–388).

Adherence to the dominant social paradigm may not only strengthen such a lock-in, but also be a source and amplification of system risk. This may in particular be the case with large-scale, top-down managed energy transitions, which treat sources and technology as a means to finding solutions, the environment as a sink, and support ignorance of limits to growth. In this paper, an empirical study among Polish students of a business university (N = 393) is presented. This study was carried out to try to test the relationship between the social paradigms, the perceptions of environmental resources and sinks and of the systemic risk in large-scale energy production (viz. nuclear power plants).

## 2. Theoretical Background and Hypotheses

The anthropocentric view of sustainability regards human expansion, development and economic growth as more important than planetary survival [36,37], and leads to an economic and marketing philosophy that proclaims consumption growth as both the means and the aim of welfare creation. This view of sustainability embraces the dominant social paradigm that humans through their technology can function independently from nature. Following Thompson et al. [38], the dominant social paradigm seems to treat "nature as a resource" where ecosystems are considered to be a resilient sink, which is "not easily pushed over the edge" [39] (p. 7). Hence, nature can be exploited as a resource and/or a sink without causing too much problems. This is reflected in a widespread belief in the benefits of abundance, in unlimited growth, and in the science and technology that supports

these. This is related to neoliberal beliefs in a laissez-faire economy, minimal government intervention, and private property rights often combined with a deep conviction that anything not used for economic gain and profit is wasted [40]. There are many examples of this, for instance: large tracts of open space and public land ownership make the Rocky Mountains of the United States perfect for large-scale solar and wind farms. Civil objections against the large-scale of these renewable energy projects are easily framed as objections to renewable energy development. The extant dominant social paradigm maintains the view that humans are superior to all other species, that the Earth provides unlimited resources for humans, and that progress is an inherent part of human history. Therefore we hypothesize:

**Hypothesis 1a.** *Adherence to the dominant social paradigm is positively related to denial of impending resource shortage.*

**Hypothesis 2a.** *Adherence to the dominant social paradigm is positively related to denial of impending pollution crisis.*

As the dominant social paradigm embraces a mismatch between short-term concrete operational thinking and long-term abstract strategic thinking, Hypothesis 2a is tested separately for general (abstract) and specific (concrete) pollution.

The dominant social paradigm also justifies existing institutions and reinforces social, political, economic, and technological courses of action that serve the interests of hegemonic groups [36,41]. Following Cotgrove [42] and Gramsci [43], this social paradigm is *"dominant . . . because it is held by dominant groups who use it to legitimise and justify prevailing institutions"* [44] (p. 194). Thus, the dominant social paradigm [44,45] represents the prevailing view among political elites and policymakers that technology, a liberal democracy, and free markets enable solutions for all kinds of economic, social, and environmental problems. This dominant mechanistic and hierarchical social paradigm may be incompatible with institutional change needed to facilitate the required energy transition. [25].

In standard economic textbooks, one can read that economic models are simplifications of reality [46]. This notwithstanding, these simplifying models tend to be frameworks for theoretical development and socioeconomic policy. Many economic models are infused with techno-optimism, with the idea that markets facilitate growth and efficiency, and the belief that growth and efficiency are the main aims of an economic system. This belief has evolved together with the dominant social paradigm as a result of the impressive increase in productivity, production capacity, and per capita national income since the Industrial Revolution [47]. Social paradigms or worldviews shape the purpose of a social system [48,49]. They support institutional and system stability [50], while, on the other hand, hampering change in inefficient systems, organizations, and institutions [51,52]. They also influence risk perception and acceptance of technology [53].

There are many reasons for ignorance of different types of risk. Ignorance can be rational [54], or be a result of a focus on short-term myopic goals [55], or due to the structure of the human brain (focus on cause–consequence explanations, quick decision-making based on emotions, etc.) [56,57], and difficulties in understanding probabilities, statistical data, and uncertainties [58]. People tend to have difficulties in grasping the nonlinear aspects of the existing threats [59], such as runaway processes in climate change [60] or chain reactions in, e.g., large-scale systems of nuclear plants having the potential to create a large-scale catastrophe [61]. In risk assessment models, the importance of unexpected events as a threat to systems sustainability is often neglected, denied, or poorly understood. Random events and processes play an important role, not only as a probabilistic driver of change [62,63]: they also reveal the vulnerabilities and fragilities in a system [64]. It can be argued that it was only a matter of time that the Fukushima Daiichi Nuclear Power Station accident in March 2011 would happen. Like most disasters [65], this disaster was man-made as "international best practices and standards" were not followed, and information "of

large tsunamis inundating the region surrounding the plant about once every thousand years" was ignored [66] (p. 1).

Mentally, a once-in-a-thousand-year event may be construed more as temporally distant than as highly improbable. This may raise questions relating to mental construal and perceived relevance, but not relating to determinance of actual behavior [67]. This high mental construal seriously hampers application of a precautionary approach, where nonlinear collapse of a system should be prevented at all costs (see [61]). This lack of determinance goes beyond the Cassandra Syndrome (i.e., valid warnings are ignored, see [68]). Taleb's theory of fat tails in risk management, in which the likeliness of small probability events happening increases through time, also does not completely capture this problem. A "(once in a) thousand year event" is certain to occur [69], though it is unknown when and how it will occur. When the event occurs, it will show the vulnerabilities and fragilities of a system that lead to nonlinear collapse. It is a certainty, where only timing of events is uncertain. We term this unpredictable certainty a LEM probability, as the concept has been inspired by Stanisław Lem's "philosophy of chance" and "chain of chances" [62,70]. The dominant social paradigm can result in consciously ignoring small-probability and nonlinear threats, exclusion of vulnerabilities from cost-benefit analyses and the neglect of "LEM probabilities" [64,71–74]. The study presented shows how the dominant social paradigm is behind a persistent denial of LEM probabilities.

Nuclear energy is a typical example of a centralized command and control approach to solving energy shortages but with a LEM probability of long-term sink damage and nuclear accidents. Large-scale integrated complex infrastructural networks such as nuclear plants are accompanied by system risks, where any type of mistake or failure may lead to large-scale consequences (see [65]). Large, irreversible system damage may require the application of the so-called precautionary principle, where proof of harmlessness is needed [61]. Irreversible ecological damage can be separated into finitism of resources (i.e., environment as a source) and pollution (i.e., the environment as a sink) or the denial of this finiteness. In the view of the above, nuclear energy may seem an attractive solution [75,76], at least as a part of a mix of energy resources [77]. Therefore we hypothesize:

**Hypothesis 3a.** *Adherence to the dominant social paradigm is positively related to acceptance of nuclear energy.*

**Hypothesis 4a.** *Adherence to the dominant social paradigm is positively related to denial of risks of nuclear energy.*

The innovation architecture for renewable energy appears to demand a shift away from anthropocentric sustainability. The power to transcend paradigms and to change "the mindset or paradigm out of which the system—its goals, structure, rules, delays, parameters—arises" are probably the most difficult but most effective leverage point towards sustainable development [49]. In this sense the dominant social paradigm is being challenged by the new ecological paradigm [78], and by (business students') attitudes towards sustainable business practices [79]. Both reflect a pro-environmental and (possibly) an eco-centric orientation. The new ecological paradigm and attitudes towards sustainable business practices may represent a worldview that moderates beliefs in and support for a particular energy source [30]. These topics are therefore also included in this research.

Contrary to the dominant social paradigm, the new ecological paradigm [78] maintains that nature is in an increasingly precarious balance, and that disruption of this balance can lead to fatal events. Technologies such as biotechnology, nuclear power or climate engineering may entail uncontrollable risks of irreversible damage. Such technologies therefore have to be strongly regulated by solid social and legal frameworks. Open markets are considered as detrimental because they structurally externalize environmental and social impacts to society and they preserve an economical–technical complex that is considered as preserving or increasing inequalities between actors. Adherents to this world view tend to show a

strong preference for local economies, and a civic society logic of participatory and deliberative decision-making and political processes. Such a system is less fragile/vulnerable than a globalized system, characterized by large, oligopolistic companies, based on the dominant social paradigm. This mindset is found for instance in NGOs and "dark-green" citizens [80] (p. 20), and is close to what Gladwin et al. [81] call the eco-centric paradigm. Attitudes toward sustainable business practices can provide a profile to select managers for successful sustainable environmental business practices. A high score on the new ecological paradigm or positive attitudes toward sustainable business practices shows that decision-makers may be willing to accept a "beyond the business case" approach and to go beyond myopic goals [82–86]. Both the new ecological paradigm and attitudes toward sustainable business practices embrace a long-term/abstract vision. Therefore, they are expected to have a relationship to nuclear energy and irreversible damage that is opposed to the influence of the dominant social paradigm. While much of the literature focuses on the relationship between worldviews and environmental attitudes [44,45,87,88], this study provides an attempt to identify worldviews as a kind of "probability amplifier" [62]. This may well be the first attempt to bridge the gap in the literature on risk perception [89]. For this reason, each hypothesis is expanded to reflect these effects:

**Hypothesis 1b.** *Adherence to the new ecological paradigm is negatively related to denial of impending resource shortage.*

**Hypothesis 1c.** *A positive attitude towards sustainable business practicesis negatively related to denial of impending resource shortage.*

**Hypothesis 2b.** *Adherence to the new ecological paradigm is negatively related to denial of impending pollution crisis.*

**Hypothesis 2c.** *A positive attitude towards sustainable business practices is negatively related to denial of impending pollution crisis.*

**Hypothesis 3b.** *Adherence to the new ecological paradigm is negatively related to acceptance of nuclear energy.*

**Hypothesis 3c.** *A positive attitude towards sustainable business practices is negatively related to acceptance of nuclear energy.*

**Hypothesis 4b.** *Adherence to the new ecological paradigm is negatively related to denial of risks of nuclear energy.*

**Hypothesis 4c.** *A positive attitude towards sustainable business practices is negatively related to denial of risks of nuclear energy.*

## 3. Method, Measures, and Material

Business schools are generally considered the epitome of the dominant social paradigm [90,91], while attitudes toward sustainable business practices of business students are relevant for less myopic approaches to corporate social responsibility [92]. It has been argued that economics and business studies teach students theoretical frameworks that do not consider small probability system risks, triggered by random events [63,71]. Curricula tend to focus on short-term thinking, graphical presentation of simple models, and on the "now and here" situation which needs to be improved in order to reduce costs by the introduction of innovations. These aims seem often to be independent of problem identification, without reference to success indicators and measures. As a consequence, short-term cost reduction can easily become the aim of any business change. While the attitudes towards business sustainability help to create a profile of students ready to manage corporate social responsibility [79],

the theoretical framework developed in this paper looks at the worldviews of future business managers as a predictor of perception of system risk.

The dominant social paradigm is focused upon in this research, as it conflicts with pro-environmental attitudes [44,45], and may be a determinant of the perception or the denial of system risks. Identifying these relationships is relevant for a paradigm change which supports the development of more sustainable energy supply [48,49]. The dominant social paradigm is a construct with three dimensions. The technological dimension is related to what Gladwin et al. [81] call the technocentric paradigm and assumes that "technofixes" to tackle sustainability challenges will always be available. The political dimension is related to liberal political processes and the idea that incremental change of legal frameworks and enforcement of existing laws are crucial factors. The economic dimension regards growth as an overall necessity. In the organization of society, large-scale control and command projects are preferred. Efficient markets and reduction of market failures are seen as the solution for all challenges to society with no apparent alternative to efficient markets [92]. The focus of our study is on the technological, political, and economic elements of the dominant social paradigm as a predictor of attitudes towards the environment as an unlimited resource and an unlimited sink for generating energy.

The dominant social paradigm items were grouped into three scales that refer to the technological, political, and economic dimension [44,45]. Culley et al. [30] measure general attitudes toward energy sources as a single multiple choice item per source. The source and sink processes are measured in the context of nuclear energy and irreversible ecological damage (see Table A2 in Appendix A). The questions were translated from English into Polish by one of the coauthors, an external scientist as well as an external translator. The translation was checked by one of the authors, and translated back for control.

In order to facilitate reproducibility of the study, the specific questions for the independent variables (dominant social paradigm, attitudes toward sustainable business practices and new ecological paradigm) are presented in Tables A1 and A3 in Appendix A. The dependent variables (nuclear energy and irreversible damage) are presented in Table A2 in Appendix A. The translated Polish language items are available on request via the first author.

The study was carried out among first-year students of logistics at a large private business university in Poland. Students of logistics were chosen because logistic chains require system analysis in the context of existing weakest links and bottlenecks, where random events can have serious, irreversible consequences. Furthermore, logistics teaching often focuses on efficiency improvements, where neglect of system risks in the increasing complexity of lengthening logistic chains can lead to severe problems (compare [59]). All the students of a course in transport economics had the opportunity to fill out the questionnaire at the beginning of the course. This was in order to prevent framing effects (part of the course dealt with sustainable development and the need for energy transition, and thus included a discussion of theoretical issues from the questionnaire). Students were informed the results would be treated confidentially, and some activity credit points could be obtained for the course. The items measured were part of a larger survey on determinants of ignorance. The results of this case study should be interpreted with care and considered a basis for future research, as the sample concerns a specific group from one country.

The survey was held during the period of online teaching between March and June 2021 using MS Forms. In total, of 558 students taking part in the course, 393 (70.4%) filled in the questionnaire. The sample consisted of 59% males and 41% females, with an average age of 22 years. Statistical analysis was carried out in R. Items belonging to the various scales were reverse-coded when necessary and joined into an average score per respondent. Single item variables were analyzed directly. This resulted in 4 dependents (nuclear solution (1 item), nuclear accidents (1 item), unlimited source (6 items, $\alpha = 0.64$), unlimited sink (8 items, $\alpha = 0.73$)) and 5 independents (dominant social paradigm technofix (4 items, $\alpha = 0.49$), dominant social paradigm politics (4 items, $\alpha = 0.55$), dominant social

paradigm economics (4 items $\alpha = 0.41$), new ecological paradigm (15 items, $\alpha = 0.72$), and attitudes toward sustainable business practices (4 items, $\alpha = 0.66$)). The dominant social paradigm constructs showed low alpha reliabilities, and satisfactory alphas for the other scales (see Appendix A for details), and results therefore must be interpreted with caution. The political and the economic dimension of the dominant social paradigm showed a correlation of 0.34, but the technofix dimension was not correlated to either.

The effects of the dominant social paradigm, attitudes toward sustainable business practices, and new ecological paradigm on the dependent variables were determined with a series of linear regressions. Each dependent variable was regressed first on the three subdimensions of the dominant social paradigm, after which attitudes toward sustainable business practices and the new ecological paradigm were added as additional predictors. Because the attitude construct absorbed all explanatory variance, a mediation analysis with attitude as mediator was added.

## 4. Results

General results as well as the tests regarding the hypotheses can be found in Appendices A and B. Below, the most important results are presented. The first two hypotheses covered the cornucopian illusions of the dominant social paradigm. Hypothesis 1a states that adherence to the dominant social paradigm predicts an optimistic attitude towards unlimited availability of global resources. The only significant predictor of unlimited resources was the political dimension, which had a negative effect. Therefore, this hypothesis was rejected. Further analysis showed no significant effect of the new ecological paradigm, but full mediation by attitudes toward sustainable business practices (Sobel's $z = 3.85$; $p = 0.0001$). In a model with the dominant social paradigm, attitudes toward sustainable business practices, and the new ecological paradigm as potential predictors, only attitudes toward sustainable business practices was significant ($B = -0.276$; SE 0.057; $t = -4.874$; $p < 0.0001$) with explained variance of 0.094 ($F(5.387) = 9.171$; $p < 0.0001$).

Hypothesis 2a states that adherence to the dominant social paradigm predicts an optimistic attitude to the environment as an unlimited sink for industrial waste. Here also, the only significant predictor of unlimited resources was its political dimension, which had a negative effect. Therefore, this hypothesis was rejected. Further analysis showed no significant effect of the new ecological paradigm, but full mediation by attitudes toward sustainable business practices (Sobel's $z = 4.65$; $p < 0.0001$). In a model with dominant social paradigm, attitudes toward sustainable business practices, and new ecological paradigm as potential predictors, only attitudes toward sustainable business practices was significant ($B = -0.373$; SE 0.054; $t = -6.860$; $p < 0.0001$) and explained variance is 0.15 ($F(5.387) = 14.48$; $p < 0.0001$).

The attitudes towards the environment as unlimited sink can be further separated into general issues such as global warming and overconsumption, and concrete issues such as agrochemicals and transport. Separate regressions of "general sink" and "concrete sink" on the dominant social paradigm, attitudes toward sustainable business practices and new ecological paradigm showed that belief in an unlimited general sink was negatively affected by attitudes toward sustainable business practices ($B = -0.448$; SE = 0.088; $p < 0.0001$), and positively by the economic dimension of the dominant social paradigm ($B = 0.32$; SE = 0.089; $p < 0.001$). Explained variance was 0.09 ($F(5.387) = 8.335$; $p < 0.0001$). Belief in unlimited concrete sink was negatively affected by attitudes toward sustainable business practices ($B = -0.328$; SE = 0.059; $p < 0.0001$), and positively by the technofix dimension of the dominant social paradigm ($B = 0.106$; SE = 0.047; $p = 0.02$). Explained variance was 0.12% ($F(5.387) = 12.09$; $p < 0.0001$).

This further analysis suggests the general belief in absence of limits is economically inspired and belief in concrete absence of limits is technologically inspired, both mediated by rejection of corporate sustainability. These combine in the overall result that the ideas of unlimited planetary resources and the environment as a sink are politically inspired, and mediated by negative attitudes toward corporate sustainability.

The latter two hypotheses covered the paradigmatic belief in centralized large-scale technofix. Hypothesis 3a states that adherence to the dominant social paradigm dimensions predicts a positive attitude about nuclear energy. Results showed that agreement with nuclear power as a solution for energy shortage was dependent on the technological dimension of the dominant social paradigm (B = 0.267, SE 0.073, $p < 0.001$) though explained variance was low ($R^2$ = 0.031; F (3.389) = 5.205; $p < 0.01$). Neither the political nor the economic dimension contributed significantly. Hypothesis 4a states that adherence to the dominant social paradigm predicts neglect of potential future damage of nuclear energy. Perceived denial of nuclear accidents was dependent on its technological dimension (B = 0.267, SE 0.074, $p < 0.001$), but lessened by the economic dimension of the dominant social paradigm (B= −0.220, SE = 0.094, $p = 0.020$). Political dimension had no significant contribution and explained variance remained low ($R^2$= 0.045; F (3.389) = 7.158; $p < 0.001$). Attitudes toward sustainable business practices and the new ecological paradigm did not add any explained variance to the dominant social paradigm's dimensions in these models. These results suggest that the technofix dimension promotes support of nuclear energy, but the economic dimension may increase the sensitivity to the risk of serious (and possibly costly) accidents.

## 5. Discussion

The results of the survey showed support for nuclear energy as a solution to global energy supply, denial of the risk of major nuclear accidents, belief in unlimited resources and unlimited sink capacity of the environment were one way or another dependent on adherence to the dominant social paradigm. This is not to say that these four issues are similar or that the relationships were uniform. The nuclear option was almost exclusively supported by the technofix dimension of the paradigm. In contrast, unlimited resource and sink beliefs were predominantly tempered by the political dimension, as expressed in support for corporate social responsibility. Furthermore, in the nuclear option, acknowledgement of the risk of disastrous accidents was fed by the economic dimension. Belief in unlimited sinks was fed by the economic dimension with respect to general issues, and by technofix with respect to concrete issues.

Our results show that the dominant social paradigm may be changing relative to Kilbourne's measures. The technofix dimension has become dissociated from the political and economic dimension, and the political dimension is as much related to attitudes toward sustainable business practices as to liberal economy. This could well mean that the current plutocratic/kleptocratic system is changing the dominant sociopolitical elements of the social paradigm. The original political dimension is geared more to (direct) democracy than the currently existing global trend towards autocracy. This may imply the need for a revision of the dominant social paradigm, as political liberalism is in demise and the hegemonic view is reflected in populist threats to democracy [93,94]. Likewise, the economic dimension of the dominant social paradigm more closely reflects capitalist free markets than the neoliberal corporate planned economies of the 21st century [95].

Acknowledgement of the finiteness of global resources is primarily fed by the liberal-democratic dimension of the (former) dominant social paradigm as manifested in attitudes toward sustainable business practices. This notwithstanding, a sustainable energy transition is hindered by vested interests and existing beliefs in large and centralized solutions. Taking nuclear energy as a textbook example of high-risk centralized energy production, our study shows that the dominant technofix paradigm predicts support for this solution. The only dissenting voice might be due to the economic consequences of large-scale accidents, such as at Harrisburg, Chernobyl, or Fukushima. Acknowledgement of the finite capacity of the environment as a sink for industrial waste is also fed by the liberal-democratic dimension of the (former) dominant social paradigm as manifested in attitudes toward sustainable business practices. Denial of this impending problem is fed by technofix beliefs regarding concrete issues and by neoliberal economics regarding general issues.

## 6. Conclusions

MBA and management-related programs in business schools and universities have been accused of producing students with uncritical adherence to neoliberal late-capitalist corporatism [91]. This profile and worldview of entrepreneurial and managerial graduates seems to encourage systematic neglect of unacceptable system risk. The study provides evidence that technological and economic dimension tend to predict downplaying the risks of irreversible damage (unlimited sink) and of limits to resource access (unlimited resource). The neglect of such risks in economic models may lead to excessive risk-taking in large-scale ventures by decision-makers whom Taleb [64] would call "fragilistas". An implication requiring more research is that decision-makers ignore system risks due to their education, mindset, and the models they use. The economic and risk assessment models underlying the dominant social paradigm, while supposedly being a simplification of reality, are rather a reflection and reinforcement of this dominant worldview [46]. Therefore, orthodox training of policymakers and decision-makers perpetuates ignoring LEM probabilities biased towards centralized oligarchic problem-solving.

The political dimension, on the other hand, has shown mixed effects. The political dimension of the dominant paradigm should enhance the perception of the Earth as an unlimited sink and resource, whereas the alternative new ecological paradigm should have the opposite relationship [96]. In this research the dominant political dimension had a reversed effect, while no relationship to the new ecological paradigm has been observed in this study. For that reason, the profile of socially responsive decision-makers (reflected by attitudes toward sustainable business practices) and political liberalism may be elementary in counteracting ignorance of system risks in large-scale energy projects. The result that liberal democracy counteracts unsustainable tendencies aligns with Bättig and Bernauer's [97] research that democratic countries show stronger commitment to less visible environmental issues such as climate change mitigation. A democracy goes in tandem with discussion, information transparency, independent scientific research, and weak stakeholders' empowerment (e.g., environmental NGOs). This brings forward the question of whether preference for less democratic systems goes in tandem with ignorance of system risk. Government bureaucracies as well as multinational oligopolies may prefer large-scale projects, such as a network of nuclear energy plants, and, while such projects may offer economies of scale, they contradict the logic of the free market and the innovative anarchy of a myriad of small entrepreneurs who experiment with local, independent energy supplies.

The results of this study need to be interpreted with care, as they concern a case study of one specific group of business students. Business students are future managers and entrepreneurs, being important stakeholders, and often decision-makers, in the needed energy transition. As strong stakeholders have the power to amplify systemic risks, the results of this study show the need for further research on whether lack of political liberalism and a negative attitude towards sustainable business practices amplify system risks in large-scale nuclear energy projects. In other words, political views and mental models regarding business sustainability may be probability amplifiers, not only creating LEM probabilities, but also making highly unlikely large-impact events more likely to happen by supporting large-scale robust, though not resilient, energy supply.

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## Appendix A

**Table A1.** Main elements of the dominant social paradigm—survey questions and results.

| Dimension of the Dominant Social Paradigm | Questions | | |
|---|---|---|---|
| Technological dimension | Advancing technology provides us with hope for the future.<br>The bad effects of technology outweigh its advantages.<br>Future resource shortages will be solved by technology.<br>Advancing technology is out of control. | 4 items,<br>Cronbach's $\alpha$ = 0.49 | M = 3.58<br>Sd = 0.96 |
| Political dimension | The average person should have more input in dealing with social problems.<br>Business interests have more political power than individuals.<br>Political equality can be attained only by major changes in election procedures.<br>Political questions are best dealt with through free market economics. | 4 items,<br>Cronbach's $\alpha$ = 0.55 | M = 5.12<br>Sd = 0.84 |
| Economic dimension | We focus too much on economic measures of well-being (left out of analysis, as in the original article of Kilbourne et al. [44]).<br>Individual behavior should be determined by economic self-interest, not politics.<br>The best measure of progress is economic.<br>If the economy continues to grow, everyone benefits. | 4 items<br>Cronbach's $\alpha$ = 0.41<br>3 items<br>$\alpha$ = 0.43 | M = 4.95<br>Sd = 0.81<br>M = 4.97<br>Sd = 0.94 |

7 point Likert-item scale (from totally disagree to totally agree). M = mean. Sd = standard deviation. Source: based on [44,45].

**Table A2.** Limited resources, irreversible damage, and nuclear—survey questions and results.

| Category | Questions | | |
|---|---|---|---|
| Unlimited source | Questions partly from environmental scale items, partly from shortages of Kilbourne et al.'s survey [44,45].<br>Since the volume of water on the earth does not change, shortages cannot occur.<br>World population levels are well within what the world can support.<br>Agricultural productivity will decline in the near future.<br>Food shortages are possible in the near future, even in developed countries.<br>Serious shortages of some natural resources will occur in the near future.<br>The following question was added in the context of the course in transport economics:<br>Serious shortages of fossil fuels are possible in the near future. | 6 items,<br>Cronbach's $\alpha$ = 0.64 | M = 3.16<br>Sd = 0.89 |
| Unlimited sink | Partly from environmental scale items and questions regarding extinction from Kilbourne et al.'s survey [44,45].<br>*Unlimited sink—general sink (denial of ecological problems)*<br>Global warming is not really a problem.<br>The problems relating to ozone depletion are overstated.<br>Our present rate of consumption can be maintained with no ecological problems.<br>*Unlimited sink—concrete sink (denial of pollution)*<br>Continued use of chemicals in agriculture will damage the environment beyond repair.<br>Continued increase in the volumes of goods transport will damage the environment beyond repair.<br>Some living things are unnecessarily being threatened with extinction.<br>Destruction of rainforests will have long term environmental consequences.<br>Many types of pollution are rising to dangerous levels. | 8 items,<br>Cronbach's $\alpha$ = 0.73 | M = 2.49<br>Sd = 0.88 |
| Nuclear | *Nuclear solution*<br>Nuclear power is the solution to energy shortages.<br>*"Nuclear accidents*<br>Nuclear accidents causing long-term damage are likely in the future. | *1 item*<br>*1 item* | *M = 4.46*<br>*Sd = 1.40*<br>*M = 3.10*<br>*Sd = 1.44* |

7 point Likert-item scale (from totally disagree to totally agree). M = mean. Sd = Standard deviation; Source: based on [44,45].

**Table A3.** Attitudes toward sustainable business practices and new ecological paradigm—survey questions and results.

| | | | |
|---|---|---|---|
| Attitudes toward sustainable business practices (questions received by courtesy of the authors, [79])<br>7 point Likert-Item scale (from totally disagree to totally agree) | I believe environmental sustainability business practices will help organizations achieve their goals and obtain (financial) benefits<br>I believe environmental sustainability business practice is the "right thing" to do, regardless of its pragmatic utility (benefits) to the organization.<br>Environmental concerns should be important to executives when companies develop and implement their strategies.<br>A company's effort to reduce its environmental impact should go beyond what the law requires even if profits might be reduced. | 4 items,<br>Cronbach's $\alpha$ = 0.66 | M = 4.85<br>Sd = 0.79 |
| New ecological paradigm [78]<br>5 point Likert-item scale (from totally disagree to totally agree) | New ecological paradigm scale items ((+) agreement means a pro- new ecological paradigm attitude (with the exception of rejection of exemptionalism), (−) agreement means an anti-new ecological paradigm attitude (with the exception of rejection of exemptionalism). Questions are numbered according to the original scale.):<br>The fragility of nature's balance:<br>3. When humans interfere with nature it often produces disastrous consequences (+); 8. The balance of nature is strong enough to cope with the impacts of modern industrial nations (−); 13. The balance of nature is very delicate and easily upset (+)<br>Possibility of an ecocrisis:<br>5. Humans are severely abusing the environment (+); 10. The so-called "ecological crisis" facing humankind has been greatly exaggerated (−); 15. If things continue on their present course we will soon experience a major ecological catastrophe (+)<br>Rejection of exemptionalism:<br>4. Human ingenuity will ensure that we do not make the Earth unlivable (−); 9. Despite their special abilities humans are still subject to the laws of nature (+); 14. Humans will eventually learn enough about how nature works to be able to control it (+)<br>Limits to growth (ecological worldview):<br>1. We are approaching the limit of the number of people the Earth can support (+); 6. The Earth has plenty of natural resources if we just learn how to develop them (−); 11. The Earth is like a spaceship with very limited room and resources(+)<br>Anti-anthropocentrism: 2. Humans have the right to modify the natural environment to suits their needs (−); 7. Plants and animals have as much right as human to exist (+); 12. Humans are meant to rule over the rest of nature (−) | 15 items,<br>Cronbach's $\alpha$ = 0.72 | M = 3.63<br>Sd = 0.40 |

Attitudes toward sustainable business practices —7 point Likert-item scale (from totally disagree to totally agree); new ecological paradigm—5 point Likert-item scale (from totally disagree to totally agree). M = mean. Sd = standard deviation; Source: [78,79].

## Appendix B

**Table A4.** Hypotheses and Tests.

| **Hypothesis 1a** | | | | | |
|---|---|---|---|---|---|
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| DSP_Technological | 0.079 | 0.046 | 1.720 | 0.08 | Rejected |
| DSP_Political | −0.221 | 0.056 | −3.949 | 0.00001 | |
| DSP_Economic | 0.038 | 0.058 | 0.660 | 0.51 | |
| **Hypothesis 1b** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| NEP | −0.073 | 0.105 | −0.690 | 0.49 | Rejected |
| **Hypothesis 1c** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| ATSBP | −0.310 | 0.053 | −5.826 | <0.000001 | Confirmed |

**Table A4.** *Cont.*

| **Hypothesis 2a** | | | | | |
|---|---|---|---|---|---|
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| DSP_Technological | 0.069 | 0.045 | 1.510 | 0.13 | Rejected |
| DSP_Political | −0.235 | 0.055 | −4.241 | 0.000003 | |
| DSP_Economic | −0.030 | 0.057 | 0.530 | 0.60 | |
| **Hypothesis 2b** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| NEP | −0.007 | 0.104 | −0.067 | 0.95 | Rejected |
| **Hypothesis 2c** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| ATSBP | −0.401 | 0.051 | −7.864 | < 0.00001 | Confirmed |
| **Hypothesis 3a** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| DSP_Technological | 0.267 | 0.073 | 3.660 | 0.0003 | Partial confirmation |
| DSP_Political | 0.064 | 0.089 | 0.721 | 0.47 | |
| DSP_Economic | 0.083 | 0.092 | 0.903 | 0.37 | |
| **Hypothesis 3b** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| NEP | 0.026 | 0.166 | 0.158 | 0.88 | Reject |
| **Hypothesis 3c** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| ATSBP | 0.186 | 0.087 | 2.142 | 0.03 | Marginal acceptance |
| **Hypothesis 4a** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| DSP_Technological | 0.267 | 0.744 | 3.587 | 0.0004 | Partial Confirmation/Partial Rejection |
| DSP_Political | −0.085 | 0.091 | −0.941 | .35 | |
| DSP_Economic | −0.220 | 0.094 | −2.332 | 0.020 | |
| **Hypothesis 4b** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| NEP | −0.026 | 0.166 | −0.158 | 0.88 | Reject |
| **Hypothesis 4c** | | | | | |
| predictor | B | SE(B) | t | *p*(t) | Evaluation |
| ATSBP | −0.115 | 0.090 | −1.280 | 0.20 | Reject |

DSP = dominant social paradigm; ATSBP = attitude towards sustainable business practices; NEP = new ecological paradigm.

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