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# ENVIRONMENTAL COMPONENT OF PRODUCT QUALITY AS A MANIFESTATION OF INDUSTRY 4.0 BUSINESS SUSTAINABILITY: IMPLICATIONS FOR COMPETITIVENESS

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A B S T R A C T

*The research aims to examine the environmental component of product quality as a manifestation of Industry 4.0 business sustainability and its implications for competitiveness. This research is based on Structural Equation Modeling (SEM) methodology on the international experience of 63 countries in 2023 using IMD and UN statistics. The authors analyze the interdependence of sustainability and competitiveness of Industry 4 .0 business, showing that improving the environmental component of product quality as a manifestation of sustainability of Industry 4 .0 business contributes to its competitiveness. The global business disparity of Industry 4.0 is reimagined from a sustainability and competitiveness perspective. The authors reveal the prospect of reducing global inequality by increasing the sustainability and competitiveness of Industry 4.0 businesses in developing countries. The main conclusion of this research is that improving the environmental component of the product quality of Industry 4.0 business products simultaneously improves sustainability and competitiveness, making the environmental component the key to consistent quality management and overcoming global inequalities – the digital and sustainability gaps.The theoretical significance of the research results lies in the fact that they clarified the cause-and-effect relationships of quality management in the business of Industry 4.0, formed a more complete understanding of management information systems in the field of business quality of Industry 4.0, and highlighted the systemic interdependence of competitiveness as the main component of product quality and additional environmental component as a manifestation of the sustainability of Industry 4.0 business. The practical significance of the author's findings and recommendations is that they will ensure the reduction of global inequality by increasing the sustainability and competitiveness of Industry 4.0 business in developing countries.*



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# 1. INTRODUCTION

The emergence of Industry 4.0 has intensified competition between businesses for opportunities to sell their products and has contributed to a rethinking of the quality of these products as a key argument in consumers' purchasing decisions. First, the most apparent and expected result of the transition to Industry 4.0 has been the transformation of competition in high-tech products. This is reflected in digital competition as a new manifestation of competition among market players. The more sophisticated and innovative the technological properties of products in Industry 4.0, the more competitive they are.

Second, a less predictable but still natural growing outcome of all four industrial revolutions has been incorporating the environmental properties of products into their quality. This was the result of a long-running contradiction between the growing needs of a technocratic society, met by industrial booms, and the needy environment that acted as a resource to meet those needs.Adopting the Sustainable Development Goals (SDGs) has transformed the environment from a source of resources to a beneficiary or victim of the industrial revolutions in general and Industry 4.0 in particular.

In this regard, quality and sustainability have become two components of the product quality of Industry 4.0 business products. The duality of quality has considerably complicated its management in the activities of Industry 4.0 business.The problem is that these components of quality conflict with each other. In this regard, two alternative approaches to product quality management of Industry 4.0 business products have emerged – competitiveness is opposed to sustainability (Bogoviz et al., 2018).

The first approach involves increasing high-tech, against the interests of caring for the environment. Improving the technical properties of the products of an Industry 4.0 business increases its competitiveness. However, this may run counter to sustainability goals. The second approach is related to introducing green innovations designed to improve the environmental properties of Industry 4.0 business products while assuming a reduction in their high-tech nature.

When implementing the outlined alternative approaches in the product quality management of Industry 4.0 business, either sustainability or competitiveness is achieved separately. The prospect of their simultaneous achievement remains unclear. This fact does not unlock the potential to improve the quality of Industry 4.0 business products. This research aims to scientifically search for a solution to the described problem and study the environmental component of product quality as a manifestation of Industry 4.0 business sustainability and its implications for competitiveness.

This introduction is followed by a literature review, which forms a view of the environmental component of product quality from the sustainable development perspective, identifies the contradiction of sustainability and competitiveness as a component of product quality in Industry 4.0 business, and highlights the shortcomings of management information systems and quality management in Industry 4.0 business.

Next, the authors present the main findings of this research, which include the following:

- The analysis of the interdependence of sustainability and competitiveness of Industry 4.0 business;
- The examination of the global business disparity of Industry 4.0 from the perspective of sustainability and competitiveness;
- The description of a perspective and the development of the author's recommendations to reduce global inequality by improving the sustainability and business competitiveness of Industry 4.0 in developing countries.

# 2. LITERATURE REVIEW

## 2.1. The environmental component of product quality: A sustainable development perspective

The environmental component of product quality is relatively new. It emerged in connection with the mass awareness of the great acuteness of global environmental problems and the need for environmental protection (Kojcic & Kuzmanovic, 2022; Masyk et al., 2023). This realization has been formalized in the form of the Sustainable Development Goals (SDGs). In this regard, it is appropriate to consider and study the environmental component of product quality from the perspective of sustainable development in the Decade of Action (Turginbayeva & Shaikh, 2022).

Content analysis of the existing literature made it possible to establish the internal structure of the environmental quality component (i.e., to identify the manifestations of business sustainability):

- Climate resilience of products, which embodies their contribution to combating climate change (i.e., the realization of SDG 13). Particularly, it is characterized by production-based nitrogen emissions (Popkova & Shi, 2022; Tolmachev et al., 2023; Vechkinzova et al., 2022);
- Product friendliness to marine ecosystems, reflecting the contribution of business to SDG 14 (Saidumohamed & Ganapathy Bhat, 2021);
- Product friendliness to marine ecosystems, reflecting business contribution to SDG 14 (Zhang et al., 2023).

The environmental component of quality is applicable to Industry 4.0 business products, which is reflected in the active adoption of green innovation with technological support for Industry 4.0 (Bazrkar et al., 2022). Many smart manufacturing facilities have improved environmental performance, from increased energy efficiency and reduced resource constraints to automated eco-labeling and eco-packaging, reduced and safely disposed of production waste, including recycling(Silva et al., 2022).

### 2.2. Product quality of Industry 4.0 business: Sustainability vs. competitiveness

The environmental component of product quality acts as a manifestation of the sustainability of Industry 4.0 business (Cardoso et al., 2022).It reflects health and environment as an outcome of SDGs 13–15 (He et al., 2023). Competitiveness represents the technical component of the product quality of Industry 4.0 business. It is reflected in the following:

- International trade, characterizing the position of business in the world markets (i.e., its global competitiveness) (Castellani et al., 2022);
- Productivity and efficiency characterizing the coherence of business processes and the breadth of quality control opportunities in business activities (Dabić et al., 2023);
- Attitudes and values characterizing the product’s consumer value (Ganjavi & Fazlollahtabar, 2023).

The existing literature (Johann et al., 2022; Popkova et al., 2022; Visvizi, 2022) provides evidence of the influence of the environmental component on the technological component of product quality. However, the nature of this influence is poorly understood and remains unclear, just as the existence of an inverse effect of competitiveness on business sustainability in Industry 4.0 has neither been confirmed nor refuted.

A common but unsupported assumption in the scientific literature (Arkin et al., 2020) is that as the environmental properties of Industry 4.0 business products improve, their technical properties naturally deteriorate (i.e., sustainability is achieved at the expense and detriment of competitiveness). Simultaneously, improving the technical properties of Industry 4.0 business products does not necessarily reduce their environmental friendliness because green digital technologies are available and actively implemented (Sardar et al., 2022).

Content analysis of the existing literature (Fahmy & Ragab, 2022) revealed that it provides fragmented data and isolated scientific facts that do not provide a holistic picture of Industry 4.0 business product quality in which sustainability and competitiveness are interlinked. The existing literature’s inherent opposition between sustainability and competitiveness (Veselovsky et al., 2018) introduces uncertainty in managing the quality of Industry 4.0 business products.

### 2.3. Shortcomings of management information systems and quality management in Industry 4.0 business, the gap in the literature, research questions (RQs), and hypotheses (H)

The conducted literature review (Lopez-Torres et al., 2022) revealed a shortcoming of management information systems in Industry 4.0 business due to the fact that these systems provide incomplete information support for the assessment, control, and management of product quality. The current vision of management information systems in Industry 4.0 business suggests that they are predominantly about either sustainability or competitiveness (Ergasheva et al., 2021).

While both of these characteristics are integral components of quality, a focus on one of them with insufficient reflection of the other does not reliably define the quality of Industry 4.0 business products with reliance on its management information systems (Vrabcová & Urbancová, 2023). The established view of product quality management in Industry 4.0 business in the existing literature suggests that it needs to choose between sustainability and competitiveness, which are opposed to each other (Kusmantini et al., 2021).

Thus, the lack of clarity on how to simultaneously achieve sustainability and product competitiveness in Industry 4.0 business activities is a gap in the literature. An obstacle to filling the identified gap is the uncertainty in the causal relationships of changes in sustainability and competitiveness of Industry 4.0 business products. While competitiveness is a core component of quality, sustainability acts as an additional component of quality. The available literature does not explain how these components are related to each other in Industry 4.0 business products (Afum et al., 2023)

This raises the following research question. **$RQ_1$:**What are the implications of improving the environmental component of product quality as a manifestation of Industry 4.0 business sustainability on its competitiveness? Liu et al. (2023) and Lopez-Torres (2023) note that improving the environmental properties of Industry 4.0 business products to the detriment of their technical properties (i.e., increasing sustainability) leads to a proportional decrease in the competitiveness of these products.

In contrast, Campos et al. (2023) and Pane (2023) say that the development of green communities in recent years has led to an increased level of environmental responsibility on the part of consumers who place greater demand on high-tech products with improved environmental properties than on products that are unfriendly to the environment. This has the effect of blurring the distinction between sustainability and competitiveness. On this basis, the authors put forward hypothesis**$H_1$**that improving the environmental component of product quality as a manifestation of Industry 4.0 business sustainability promotes competitiveness.

Content analysis of existing literature (Iqbal et al., 2023; Urbancová & Vrabcová, 2023) also showed that the shortcoming of product quality management in Industry 4.0 business is related to the differentiation of quality levels among countries. This differentiation is so strong that it is called "the gap." Moreover, it is so distinct that this differentiation is not just among countries in the general mass but between certain categories of countries (developed and developing ones).

The digital divide has emerged with the transition to Industry 4.0. It consists of developed countries significantly and systemically outperforming developed countries in the global digital competitiveness of products (Sergi et al., 2019). The environmental divide has deep historical roots going back to the 20$^{th}$ century. With the adoption of the UN SDGs, its concept has evolved, and it is now more correctly called the sustainability divide (Kusakina et al., 2016).

It consists of the fact that developed countries were the first to embark on the path of building a green economy and, at first, were far ahead of developing countries on this path. Developing countries also took this path, becoming significantly concerned about their environment and achieving outstanding results in its protection. These countries are now far ahead of developed countries in the environmental friendliness of their products (Karrieva, 2019).

The reasons for the noted shortcoming are well known.They consist of the fact that developed countries were the first to launch national programs of digital modernization of the economy, gain leadership in the field of high-tech industries (this is the reason for the digital gap in the field of competitiveness), and transfer environmental costs of economic growth of developed countries to developing countries through the affiliate network of transnational corporations. Then, developing countries achieved intensive green growth in their economies (this is the reason for the gap in sustainable economic growth).Thus, the prospect of overcoming this shortcoming is unclear, which is another gap in the literature (Hallioui et al., 2022; Karia, 2022).

This raises the following research question. **RQ$_2$:**How to bridge the product quality gap in Industry 4.0?Soledispa-Cañarte et al. (2023a, 2023b) state that the attempts of developing countries to improve the environmental properties of products reduce the competitiveness of their Industry 4.0 business products.
In contrast, Hallioui et al. (2022) and Saunila et al. (2023) draw attention to the fact that increasing environmental friendliness increases quality, thereby contributing to competitiveness. On this basis, the authors put forward hypothesis**H$_2$**that bridging the product quality gap in Industry 4.0 is facilitated by improving the environmental component of the quality of Industry 4.0 business products in developing countries, simultaneously enhancing sustainability and competitiveness.

To verify the hypotheses put forward in this research, based on international experience, the authors study the practice of quality management in Industry 4.0 business, the formation of management information systems, and the gap in the field of quality. Moreover, the authors model the system interdependence of competitiveness as the main component of product quality and an additional environmental component as a manifestation of the sustainability of Industry 4.0 business.

## 3. MATERIALS AND METHODOLOGY

The sample of this study comprises 63 countries for which IMD (2023)digital competitiveness statistics are kept, including developed countries (OECD) and developing countries. The generated sample accurately reflects and provides the most comprehensive insight into Industry 4.0 business. It is provided in the Appendix to this research. The research is based on data for 2023. There are four research objectives.

The first objective is to analyze the interdependence of sustainability and business competitiveness of Industry 4.0.It is solved by using regression analysis. The chosen method is applied, first, to determine direct regression dependence of the indicators reflecting the competitiveness of Industry 4.0 business products (calculated by the international trade ($Cptv_1$), productivity and efficiency ($Cptv_2$), and attitudes and values ($Cptv_3$))on health and environment (Sust) as an indicator that reflects the sustainability of this business based on IMD (2023) statistics. Moreover, this method is used to determine the inverse dependence of Sust on factors $Cptv_{1-3}$. Based on the analysis, the following linear regression equations are prepared:

$$Cptv=a_{Cptv}+b_{Cptv}*Sust \quad (1)$$

$$Sust=a_{Sust1}+b_{Sust1}*Cptv_1+b_{Sust2}*Cptv_2+b_{Sust3}*Cptv_3 \quad (2)$$

Hypothesis **H$_1$** is recognized and proven if the regression coefficient in equation (1) takes a positive value ($b_{Cptv}$>0). This would indicate that an increase in Sust contributes to an increase inCptv. That is, improving the environmental component of product quality as a manifestation of the sustainability of Industry 4.0 business contributes to its competitiveness.
Second, this method is used to determine the direct regression dependence of Sust on factors reflecting the internal structure of the environmental quality component (production-based nitrogen emissions ($EnvQ_1$), SDG14 ($EnvQ_2$),and SDG15 ($EnvQ_3$))relying on UN (2023), as well as the inverse dependence of$EnvQ_{1-3}$on Sust. Correlation and variance analyses are

performed in addition to regression statistics.The reliability of the analysis results is assessed using Fisher's F-test and Student's t-test.

$$Sust=a_{Sust2}+b_{Sust4}*EnvQ_1+b_{Sust5}*EnvQ_2+b_{Sust6}*EnvQ_3 \quad (3)$$

$$EnvQ=a_{EnvQ}+b_{EnvQ}*Sust \quad (4)$$

To form a systemic vision of the interdependence of sustainability and competitiveness of Industry 4.0 business, the authors apply the structural equation modeling method: the regression analysis results are combined into a SEM model. The choice of methodology in this research is explained by the fact that, unlike correlation analysis, the SEM method makes it possible to identify the relationship of indicators and their interdependence. Unlike regression analysis, the SEM method allows for establishing direct and inverse relationships of indicators and presenting the results systemically.

The second objective is to explore the global inequality of Industry 4.0 business from the sustainability and competitiveness perspective. For this purpose, arithmetic averages of all studied variables ($Cptv_{1-3}$, Sust, and $EnvQ_{1-3}$)are calculated separately among developed (OECD) and developing countries. On this basis, the authors determine the scale of global inequality as the ratio of the average value in developed countries to the average value in developing countries (in percent).

The third objective is to identify the prospectsfor reducing global inequality by increasing the sustainability and competitiveness of Industry 4.0 business in developing countries. To solve this task, the authors substitute the optimal values of $EnvQ_{1-3}$ (according to UN (2023)) into regressions (1)–(4), determine the expected values of other variables in developing countries, and estimate their growth rate in the Decade of Action (i.e., up to 2030) (change of values compared to 2023).

On this basis, the authors develop recommendations to reduce global inequality through increasing the sustainability and competitiveness of Industry 4.0 business in developing countries.Hypothesis**$H_2$**is considered proven if the optimization of $EnvQ_{1-3}$values in developing countries will make their arithmetic averages of $Cptv_{1-3}$and Sust reach the level of arithmetic averages of developed countries. This would suggest that increasing improvements in the environmental component of the product quality of Industry 4.0 business in developing countries can potentially bridge the product quality gap in Industry 4.0while contributing to sustainability and competitiveness.

## 4. RESULTS

### 4.1. Analysis of the interdependence of sustainability and competitiveness of Industry 4 .0 business

To meet the first objective and analyze the interdependence of sustainability and competitiveness of Industry 4.0 business, the authors applied regression analysis to determine the dependence of competitiveness ($Cptv_{1-3}$) on Sust as an indicator of the sustainability of Industry 4.0 business (Tables 1–3).

**Table 1.**Regression analysis of the dependence of international trade on health and environment in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0.3326 | | | | | |
| $R^2$ | 0.1106 | | | | | |
| Normalized $R^2$ | 0.0960 | | | | | |
| Standard error | 17.8856 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 2426.9375 | 2426.9375 | 7.5867 | 0.0077 | |
| Residual | 61 | 19513.4752 | 319.8930 | | | |
| Total | 62 | 21940.4127 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 22.2861 | 4.5803 | 4.8656 | 0.000008 | 13.1271 | 31.4450 |
| Sust | 0.3289 | 0.1194 | 2.7544 | 0.0077 | 0.0901 | 0.5676 |

*Source: Calculated and compiled by the authors.*

The results obtained in Table 1 imply that the change in international trade in the sample countries in 2023 is by 33.26% determined by the impact of changes in health and environment. These results allow us to generate the following regression equation:

$$Cptv_1=22.2861+0.3289*Sust \quad (5)$$

Equation (5) shows that when health and environment increase by 1 rank, international trade increases by 0.3289 ranks. Fisher's F-test passed at the significance level of 0.01 – significance F=0.0077 at 63 observations and 1 factor variable ($k_1$=1, $k_2$=61);tabular F=7.0695;observed F=7.5867. Student's t-test was passed at the significance level of 0.01 – with 62 degrees of freedom, tabular t=2.6575;with factor variable Sust, observed t=2.7544. The tests performed confirmed the reliability of equation (5) at the significance level of 0.01.

The results obtained in Table 2 imply that the change in productivity and efficiency in the sample countries in 2023 is by 73.19% determined by the impact of changes in health and environment. These results allow us to generate the following regression equation:

$$Cptv_1=9.4912+0.7353*Sust \quad (6)$$

Equation (6) shows that when health and environment increase by 1 rank, productivity and efficiency increase by 0.7353 ranks. Fisher's F-test passed at the significance level of 0.01 – significance $F=9.4*10^{-12}$at 63 observations and 1 factor variable ($k_1$=1, $k_2$=61);tabular F=7.0695;observed F=70.3788. Student's t-test was passed at the significance level of 0.01 – with 62 degrees of freedom, tabular t=2.6575;with factor variable Sust, observed t=8.3892. The tests performed confirmed the reliability of equation (6) at the significance level of 0.01.

**Table 2.**Regression analysis of the dependence of productivity and efficiency on health and environment in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0.7319 | | | | | |
| $R^2$ | 0.5357 | | | | | |
| Normalized $R^2$ | 0.5281 | | | | | |
| Standard error | 13.1287 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 12130.7107 | 12130.7107 | 70.3788 | $9.4*10^{-12}$ | |
| Residual | 61 | 10514.1464 | 172.3631 | | | |
| Total | 62 | 22644.8571 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 9.4912 | 3.3622 | 2.8229 | 0.0064 | 2.7681 | 16.2142 |
| Sust | 0.7353 | 0.0876 | 8.3892 | $9.4*10^{-12}$ | 0.5600 | 0.9106 |

*Source: Calculated and compiled by the authors.*

**Table 3.** Regression analysis of the dependence of attitudes and values on health and environment in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0.3732 | | | | | |
| $R^2$ | 0.1393 | | | | | |
| Normalized $R^2$ | 0.1251 | | | | | |
| Standard error | 17.4685 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 3011.4266 | 3011.4266 | 9.8688 | 0.0026 | |
| Residual | 61 | 18614.0020 | 305.1476 | | | |
| Total | 62 | 21625.429 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 21.5268 | 4.4735 | 4.8120 | $1*10^{-5}$ | 12.5814 | 30.4722 |
| Sust | 0.3664 | 0.1166 | 3.1415 | 0.0026 | 0.1332 | 0.5996 |

*Source: Calculated and compiled by the authors.*

The results obtained in Table 3 imply that the change in attitudes and values in the sample countries in 2023 is by 37.32% determined by the impact of health and environment. These results allow us to generate the following regression equation:

$$Cptv_1=21.5268+0.3664*Sust \quad (7)$$

Equation (7) shows that when health and environment increase by 1 rank, international trade increases by 0.3664 ranks. Fisher's F-test passed at the significance level of 0.01 – significance F=0.0026 at 63 observations and 1 factor variable ($k_1$=1, $k_2$=61);tabular F=7.0695;observed F=9.8688. Student's t-test was passed at the significance level of 0.01: with 62 degrees of freedom, tabular t=2.6575; with factor variable Sust, observed t=3.1415. The tests performed confirmed the reliability of equation (5) at the significance level of 0.01. The regression dependence of Sust on factors reflecting the internal structure of the environmental quality component ($EnvQ_{1-3}$) is defined in Table 4.

**Table 4.** Regression analysis of the dependence of health and environment on the factors of environmental quality component in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0.3229 | | | | | |
| $R^2$ | 0.1043 | | | | | |
| Normalized $R^2$ | 0.0587 | | | | | |
| Standard error | 18.4564 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 3 | 2339.4554 | 779.8185 | 2.2893 | 0.0877 | |
| Residual | 59 | 20097.6239 | 340.6377 | | | |
| Total | 62 | 22437.0794 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 37.7604 | 14.1009 | 2.6779 | 0.0096 | 9.5444 | 65.9763 |
| $EnvQ_1$ | 0.2013 | 0.1124 | 1.7900 | 0.0786 | -0.0237 | 0.4263 |
| $EnvQ_2$ | -0.0125 | 0.0900 | -0.1391 | 0.8899 | -0.1927 | 0.1677 |
| $EnvQ_3$ | -0.2189 | 0.1482 | -1.4772 | 0.1449 | -0.5154 | 0.0776 |

*Source: Calculated and compiled by the authors.*

The results obtained in Table 4 imply that the change in health and environment in the sample countries in 2023 is by 37.32% determined by the impact of changes in factors reflecting the internal structure of the environmental component of quality. These results allow us to generate the following regression equation:

$$Sust=37.7604+0,2013*EnvQ_1-0.0125*EnvQ_2-0.2189*EnvQ_3 \quad (8)$$

Equation (8) shows that when production-based nitrogen emissions are reduced by 1 kg/capita, health and environment improve by 0.2013 ranks. A 1 rank increase in SDG 14 improves health and environment by 0.0125 ranks. If SDG 15 increases by 1 rank, health and environment improve by 0.2189 ranks.

Fisher's F-test passed at the significance level of 0.1 – significance F=0.0877, at 63 observations and 1 factor variable ($k_1$=3, $k_2$=59); tabular F=2.1790; observed F=92.2893. Student's t-test was passed for factor variable $EnvQ_1$ (observed t=1.7900) at the significance level of 0.1 (tabular t=1.6698) and for factor variable $EnvQ_1$ (observed t=-1.4772) at the significance level of 0.15 (tabular t=1.4576). The tests performed confirmed the reliability of equation (8) at the significance level of 0.15.

The regression dependence of Sust on competitiveness factors ($Cptv_{1-3}$) is defined in Table 5.

**Table 5.** Regression analysis of the dependence of health and environment on competitiveness factors in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0.7795 | | | | | |
| $R^2$ | 0.6077 | | | | | |
| Normalized $R^2$ | 0.5877 | | | | | |
| Standard error | 12.2143 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 3 | 13634.8775 | 4544.9592 | 30.4643 | $5*10^{-12}$ | |
| Residual | 59 | 8802.2018 | 149.1899 | | | |
| Total | 62 | 22437.0794 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 15.1848 | 3.7474 | 4.0521 | 0.0002 | 7.6864 | 22.6832 |
| $Cptv_1$ | -0.2950 | 0.1102 | -2.6780 | 0.0096 | -0.5154 | -0.0746 |
| $Cptv_2$ | 1.0950 | 0.1382 | 7.9248 | $7.3*10^{-11}$ | 0.81852 | 1.3715 |
| $Cptv_3$ | -0.2742 | 0.1139 | -2.4064 | 0.0193 | -0.5021 | -0.0462 |

*Source: Calculated and compiled by the authors.*

The results obtained in Table 5 imply that the change in health and environment in the sample countries in 2023 is by 37.32% determined by the impact of changes in competitiveness factors. These results allow us to generate the following regression equation:

$$Sust=15.1848-0.2950*Cptv_1+1.0950*Cptv_2-0.2742*Cptv_3 \quad (9)$$

Equation (9) shows that when international trade increases by 1 rank, health and environment decrease by 0.2950 ranks. If productivity and efficiency improve by 1 rank, health and environment improve by 1.0950 rank.If attitudes and values improve by 1 rank, health and environment deteriorate by 0.2742 ranks.

Fisher's F-test passed at the significance level of 0.01 – significance $F=5*10^{-12}$at 63 observations and 3 factor variables ($k_1=3$, $k_2=59$); tabular F=2.1790;observed F=30.4643. Student's t-test was passed for factor variable $Cptv_2$ (observed t=7.9248) at the significance level of 0.01 (tabular t=2.6575) and for factor variables $Cptv_1$ (observed t=-2.6780) and $Cptv_3$ (observed t=-2.4064) at the significance level of 0.05 (tabular t=1.9990). The tests performed confirmed the reliability of equation (9) at the significance level of 0.05.

The regression dependence of indicators reflecting the internal structure of the environmental quality component ($EnvQ_{1-3}$) on Sust is defined in Tables 6–8.

**Table 6.** Regression analysis of the dependence of production-based nitrogen emissions on health and environment in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0.2656 | | | | | |
| $R^2$ | 0.0706 | | | | | |
| Normalized $R^2$ | 0.0553 | | | | | |
| Standard error | 20.7542 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 1994.8340 | 1994.8340 | 4.6312 | 0.0354 | |
| Residual | 61 | 26275.0050 | 430.7378 | | | |
| Total | 62 | 28269.8390 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 46.7642 | 5.3150 | 8.7985 | 0.0000 | 36.1362 | 57.3922 |
| Sust | 0.2982 | 0.1386 | 2.1520 | 0.0354 | 0.0211 | 0.5752 |

*Source: Calculated and compiled by the authors.*

The results obtained in Table 6 show that the change in production-based nitrogen emissions in the sample countries in 2023 is by26.56% determined by the impact of health and environment. These results allow us to generate the following regression equation:

$$EnvQ_1=46.7642+0.2982*Sust \qquad (10)$$

Equation (10) shows that when health and environment improve by 1 rank, production-based nitrogen emissions are reduced by 0.2982 kg/capita. Fisher's F-test passed at the significance level of 0.05 – significance F=0.0354 at 63 observations and 1 factor variable ($k_1=1$, $k_2=61$);tabular F=3.9985;observed F=4.6312. Student's t-test was passed at the significance level of – with 62 degrees of freedom, tabular t=1.9990;with factor variable Sust, observed t=2.1520. The tests performed confirmed the reliability of equation (10) at the significance level of 0.05.

**Table 7.** Regression analysis of the dependence of SDG 14 on health and environment in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0,0185 | | | | | |
| $R^2$ | 0,0003 | | | | | |
| Normalized $R^2$ | -0,0160 | | | | | |
| Standard error | 26,2618 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 14.4092 | 14.4092 | 0.0209 | 0.8855 | |
| Residual | 61 | 42070.6186 | 689.6823 | | | |
| Total | 62 | 42085.0278 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 58.0196 | 6.7254 | 8.6269 | 3.7E-12 | 44.5712 | 71.4679 |
| Sust | -0.0253 | 0.1753 | -0.1445 | 0.8855 | -0.3759 | 0.3252 |

*Source: Calculated and compiled by the authors.*

The results obtained in Table 7 show that the change in SDG14 in the sample countries in 2023 is by 1.85% determined by the influence of the change in health and environment. Fisher's F-test is not passed, and Student's t-test is passed. Consequently, health and environment have no statistically significant effect on SDG 14.

The results obtained in Table 8 show that the change in SDG15 in the sample countries in 2023 is by 23.56% determined by the influence of the change in health and environment. These results allow us to generate the following regression equation:

$$EnvQ_3=46.7642+0.2982*Sust \qquad (11)$$

**Table 8.** Regression analysis of the dependence of SDG 15 on health and environment in 2023

| *Regression statistics* | | | | | | |
|---|---|---|---|---|---|---|
| Multiple R | 0.2356 | | | | | |
| $R^2$ | 0.0555 | | | | | |
| Normalized $R^2$ | 0.0400 | | | | | |
| Standard error | 15.8799 | | | | | |
| Observations | 63 | | | | | |
| Variance analysis | | | | | | |
| | *df* | *SS* | *MS* | *F* | *Significance F* | |
| Regression | 1 | 904.0079 | 904.0079 | 3.5849 | 0.0631 | |
| Residual | 61 | 15382.4124 | 252.1707 | | | |
| Total | 62 | 16286.4204 | | | | |
| | *Coefficients* | *Standard error* | *t-statistics* | *P-value* | *Lower 95%* | *Upper 95%* |
| Y-intercept | 75.5202 | 4.0667 | 18.5703 | $8.7*10^{-27}$ | 67.3883 | 83.6520 |
| Sust | -0.2007 | 0.1060 | -1.8934 | 0.0631 | -0.4127 | 0.0113 |

*Source: Calculated and compiled by the authors.*

Equation (10) shows that when health and environment improve by 1 rank, SDG15decreases by 0.2982 ranks. Fisher's F-test passed at the significance level of 0.10 – significance F=0.0631 at 63 observations and 1 factor variable ($k_1$=1, $k_2$=61);tabular F=2.7896;observed F=3.5849. Student's t-test was passed at the significance level of 0.10 – with 62 degrees of freedom, tabular t=1.96698;with factor variable Sust, observed t=-1.8934. The tests performed confirmed the reliability of equation (11) at the significance level of 0.10.

The following SEM model reflects a systemic view of the interdependence of sustainability and competitiveness of Industry 4.0 business (Figure 1).

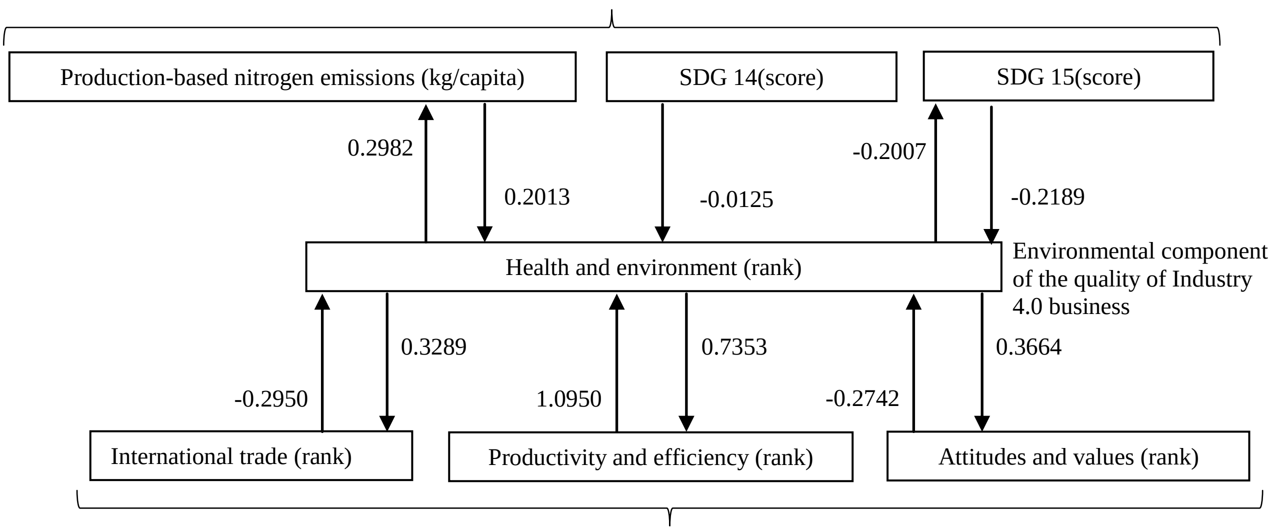


**Figure 1.** SEM model of the interdependence of sustainability and business of Industry 4.0 competitiveness.
*Source: Developed and compiled by the authors.*

The SEM model (Figure 1) showed the close interdependence of sustainability and competitiveness of Industry 4.0 business, which act as catalysts for each other.

Thus, in equations (5)-(7), the regression coefficients took positive values and were 0.3289, 0.7535, and 0.3664, respectively. This proves hypothesis$\mathbf{H_1}$and indicates that an increase in Sust contributes to an increase in Cptv (i.e., improving the environmental component of product quality as a manifestation of industry 4.0 business sustainability).

### 4.2. Global business inequality of Industry 4.0 from a sustainability and competitiveness perspective

To address the second research objective and study the global inequality of Industry 4.0 business from the sustainability and competitiveness perspective, the authors calculated the arithmetic averages of all studied variables ($Cptv_{1-3}$, Sust, and $EnvQ_{1-3}$) separately among developed (OECD) and developing countries (Figure 2).

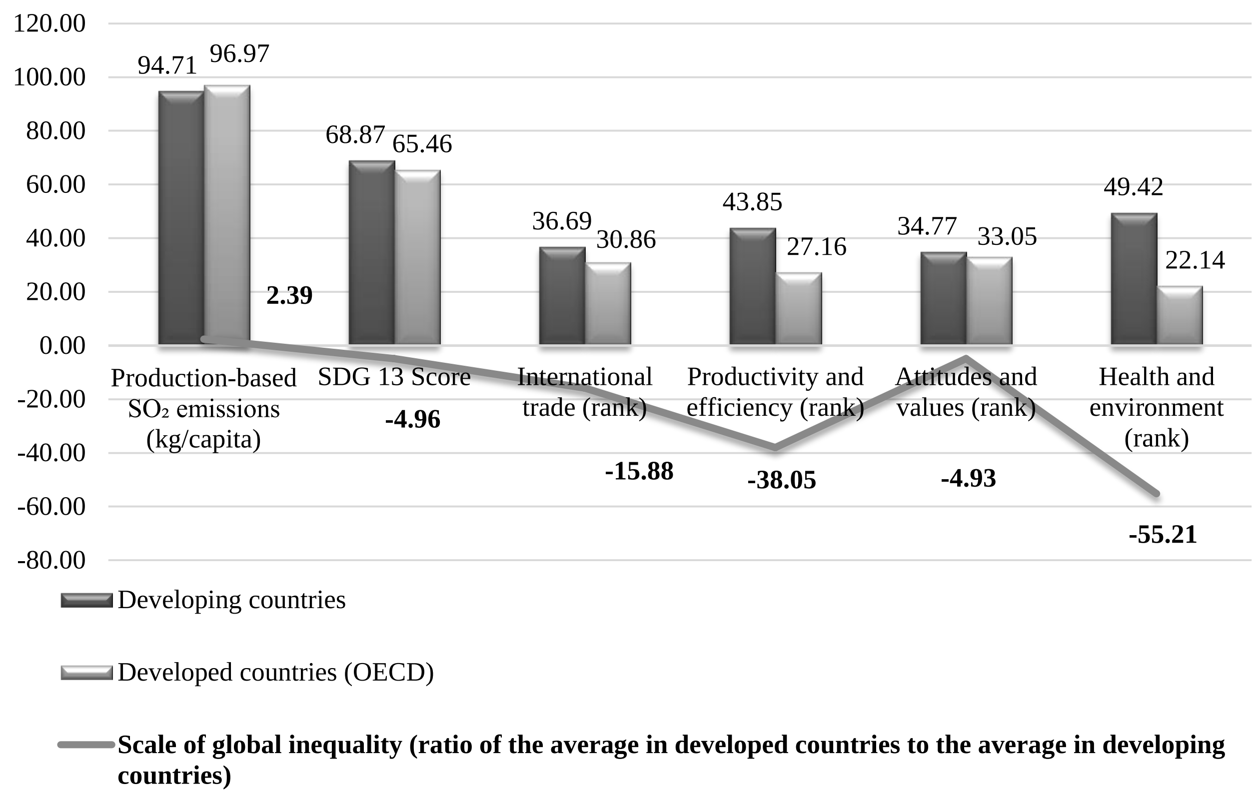


**Figure 2.** Global inequality of Industry 4.0 business from a sustainability and competitiveness perspective.
*Source: Calculated and compiled by the authors.*

The ratio of the average value in developed countries to the average value in developing countries is determined based on the arithmetic averages from Figure 2.The scale of global inequality in 2023 was as follows: international trade – -15.88%, productivity and efficiency – -38.05%, attitudes and values – -4.93%, health and environment – -55.21%, production-based nitrogen emissions – 2.39%, SDG14 – -4.96%, and SDG15 – -15.88%.

Consequently, the digital divide is characterized by the leadership of developed countries in competitiveness as a component of product quality in the Industry 4.0 business.The sustainability gap is characterized by the leadership of developing countries in the environmental component of product quality in Industry 4.0 business.

### 4.3. Recommendations for reducing global inequality by enhancing the sustainability and competitiveness of Industry 4.0 businesses in developing countries

To address the third objective and determine the prospect of reducing global inequality through increasing the sustainability and competitiveness of Industry 4.0 business in developing countries, the optimal (according to the UN materials (UN, 2023)) values of indicators $EnvQ_{1-3}$are substituted into the regression equations (5)–(8), the expected values of other variables in developing countries are determined, and their growth rate in the Decade of Action (i.e., until 2030) (change of value compared to 2023) is estimated. The obtained results are presented in Figure 3.

The perspective revealed in Figure 3 showed that the optimization of the environmental component of the quality of Industry 4.0 business products ($EnvQ_1$=2 kg/capita, $EnvQ_2$=100 score, and $EnvQ_3$=100 score) in developing countries would increase their arithmetic averages of $Cptv_{1-3}$ and Sust to the level of the arithmetic averages of developed countries:

- Health and environment will improve by 55.02% to 22.23 rank (22.14 in developed countries);
- International trade will improve by 18.17% to 30.03 ranks (30.86 in developed countries);
- Productivity and efficiency will improve by 39.68% to 26.45 ranks (27.16 in developed countries);
- Attitudes and values will improve by 19.94% to 27.84 ranks (33.05 in developed countries).

Based on this, the authors developed the following recommendations to reduce global inequality by increasing the sustainability and competitiveness of Industry 4.0 businesses in developing countries:

- Reduction of production-based nitrogen emissions by 96.23%;
- Increase in SDG14 score by 79.60%;
- Increase in SDG15 score by 34.70%.

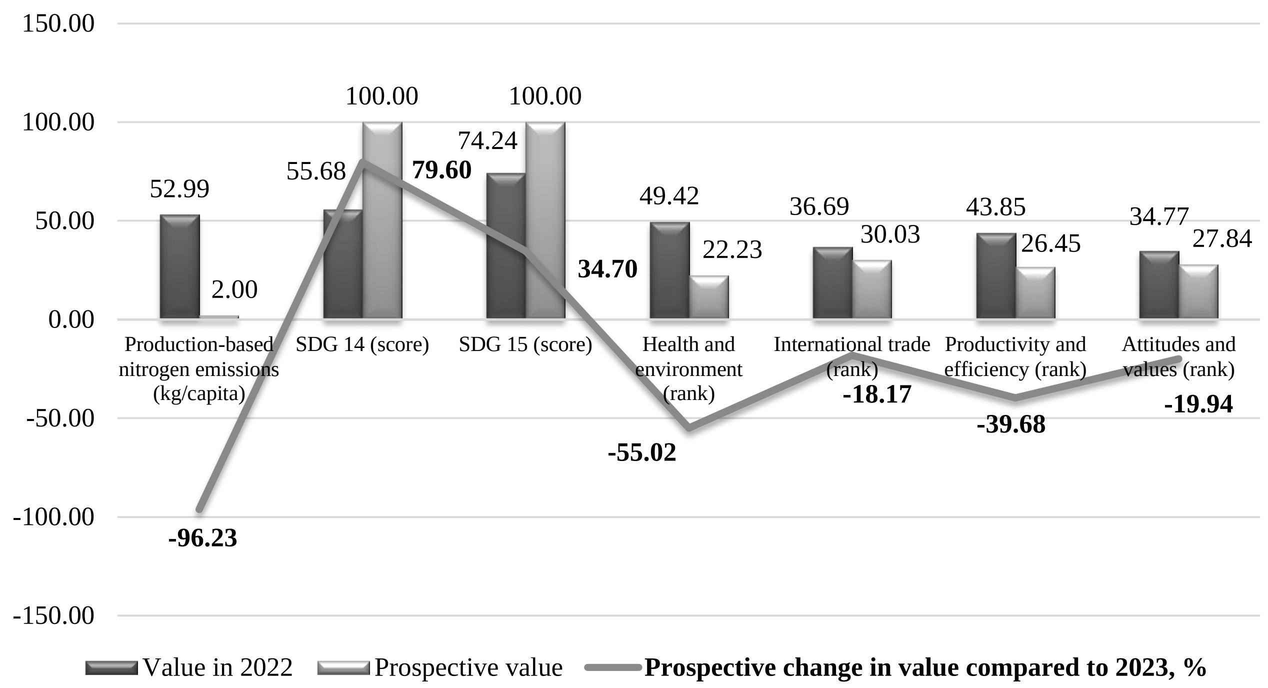


**Figure 3.** Perspective on reducing global inequality by enhancing the sustainability and competitiveness of Industry 4.0 business in developing countries.
*Source: Calculated and compiled by the authors.*

Thus, the findings prove hypothesis $\mathbf{H_2}$ and suggest that increasing improvements in the environmental component of the quality of Industry 4.0 business products in developing countries can potentially bridge the product quality gap in Industry 4.0, contributing to sustainability and competitiveness.

## 5. DISCUSSION

The contribution of this research to the literature lies in developing the concept of management information systems through overcoming the deficiency of these systems in Industry 4.0 business because these systems provide incomplete information support for product quality assessment, control, and management. The resulting responses to the RQs are summarized in Table 8 and compared with the available literature.

As shown in Table 8, this research produced a new response to RQ1. In contrast to Liu et al. (2023) and Lopez-Torres (2023), it is substantiated that the increase in sustainability leads not to an increase in the competitiveness of these products (hypothesis $\mathbf{H_1}$is proven in support of Campos et al. (2023) and Pane (2023)).

**Table 8.** Responses received to RQs compared with the available literature

| Research questions | Answers in the literature | Answers in the research |
|---|---|---|
| **$RQ_1$:**What are the implications of improving the environmental component of product quality as a manifestation of Industry 4.0 business sustainability on its competitiveness? | An increase in sustainability leads to a proportional decrease in the competitiveness of these products (Liu et al., 2023; Lopez-Torres, 2023) | Improving the environmental component of product quality as a manifestation of the sustainability of Industry 4.0 business contributes to increased competitiveness (hypothesis $\mathbf{H_1}$ is proven) |
| **$RQ_2$:**How to bridge the product quality gap in Industry 4.0? | Attempts of developing countries to improve the environmental properties of products reduce the competitiveness of their products produced by the Industry 4.0 business (Soledispa-Cañarte et al., 2023a, 2023b) | Bridging the product quality gap in Industry 4.0 contributes to improving the environmental component of product quality in Industry 4.0 business in developing countries, thereby enhancing sustainability and competitiveness(hypothesis $\mathbf{H_2}$is proven) |

*Source: Developed and compiled by the authors.*

The research also has a new response to $\mathbf{RQ_2}$. In contrast to Soledispa-Cañarte et al. (2023a, 2023b),It is substantiated that the attempts of developing countries to improve the environmental properties of products increase the competitiveness of their products of Industry 4.0 business, which contributes to overcoming the gap in product quality in Industry 4.0 (hypothesis $\mathbf{H_2}$is proven in support of Hallioui et al. (2022) and Saunila et al. (2023)).

Thus, the scientific novelty of the results obtained in the research and the author's conclusions based on them is that they have formed a new vision of management information systems in the Industry 4.0 business, systemically reflecting its sustainability and competitiveness.

## 6. CONCLUSION

The main conclusion of this research is that improving the environmental component of the quality of Industry 4.0 business products simultaneously improves sustainability and competitiveness, making the environmental component the key to consistent quality management and overcoming global inequalities (the digital and sustainability gaps).This conclusion is based on the following research results:

1. The authors analyzed the interdependence of sustainability and competitiveness of Industry 4 .0 business, showing that improving the environmental component of product quality as a manifestation of sustainability of Industry 4 .0 business contributes to its competitiveness. Based on the results of the analysis, the SEM model was compiled, which formed a systemic vision of the interdependence of sustainability and competitiveness of Industry 4.0 business;
2. The authors reimagined the global business inequality of Industry 4.0 from a sustainability and competitiveness perspective. It is found that the digital divide is characterized by the leadership of developed countries in competitiveness as a component of the quality of Industry 4.0 business products.The sustainability gap is characterized by the leadership of developing countries in the environmental component of the quality of Industry 4.0 business products;
3. The authors revealed the prospect of reducing global inequality by increasing the sustainability and competitiveness of Industry 4.0 businesses in developing countries. For this purpose, developed countries in the Decade of Action are recommended to reduce production-based nitrogen emissions by 96.23%, increase the SDG 14 score by 79.60%, and increase the SDG 15 score by 34.70%.This will comprehensively improve the quality of Industry 4.0 business products in the unity of its environmental and technical components: health and environment will increase to 22.23 rank, international trade will increase to 30.03 ranks, productivity and efficiency will increase to 26.45 ranks, and attitudes and values will increase to 27.84 ranks. That is, the sustainability and competitiveness of Industry 4.0 business products in developing countries will reach the level of developed countries.

The theoretical significance of the results lies in the fact that they clarified the cause-and-effect relationships of quality management in Industry 4.0 business, formed a more complete understanding of management information systems in the field of business quality of Industry 4.0, and highlighted the systemic interdependence of competitiveness as the main component of product quality and additional environmental component as a manifestation of the sustainability of Industry 4.0 business. The practical significance of the author's findings and recommendations is that they will ensure the reduction of global inequality by increasing the sustainability and competitiveness of Industry 4.0 businesses in developing countries.

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## Appendix

| Category of countries | Regions used for the SDR | Country | Competitiveness | | | Sustainability | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | International trade (rank) | Productivity and efficiency (rank) | Attitudes and values (rank) | Health and Environment (rank) | Production-based nitrogen emissions (kg/capita) | Goal 14 Score | Goal 15 Score |
| Developing countries | E. Europe & C. Asia | Bulgaria | 22 | 60 | 60 | 52 | 54.271 | 65.7 | 94.1 |
| Developing countries | E. Europe & C. Asia | Croatia | 16 | 46 | 59 | 39 | 63.855 | 84.6 | 88.2 |
| Developing countries | E. Europe & C. Asia | Cyprus | 48 | 48 | 54 | 31 | 66.053 | 50.2 | 79.0 |
| Developing countries | E. Europe & C. Asia | Kazakhstan | 48 | 40 | 29 | 56 | 42.985 | 0.0 | 62.5 |
| Developing countries | E. Europe & C. Asia | Romania | 44 | 37 | 40 | 48 | 61.252 | 86.7 | 79.5 |
| Developing countries | E. Europe & C. Asia | Russian Federation | 64 | 64 | 64 | 64 | 59.992 | 53.4 | 66.1 |
| Developing countries | East & South Asia | China | 39 | 31 | 14 | 33 | 68.458 | 55.7 | 48.9 |
| Developing countries | East & South Asia | India | 35 | 39 | 23 | 62 | 84.165 | 62.3 | 45.6 |
| Developing countries | East & South Asia | Indonesia | 49 | 42 | 12 | 58 | 79.456 | 69.8 | 51.4 |
| Developing countries | East & South Asia | Malaysia | 14 | 36 | 34 | 42 | 70.586 | 68.2 | 38.4 |
| Developing countries | East & South Asia | Mongolia | 61 | 62 | 39 | 64 | 0 | 0.0 | 74.9 |
| Developing countries | East & South Asia | Philippines | 60 | 52 | 32 | 60 | 88.237 | 74.9 | 58.6 |
| Developing countries | East & South Asia | Singapore | 2 | 6 | 13 | 26 | 82.809 | 47.2 | 26.5 |
| Developing countries | East & South Asia | Thailand | 29 | 38 | 19 | 53 | 69.196 | 64.2 | 60.2 |
| Developing countries | LAC | Argentina | 53 | 55 | 64 | 51 | 36.666 | 61.7 | 60.0 |
| Developing countries | LAC | Brazil | 51 | 63 | 55 | 45 | 60.98 | 63.8 | 61.7 |
| Developing countries | LAC | Peru | 59 | 61 | 49 | 57 | 78.254 | 78.7 | 55.3 |
| Developing countries | LAC | Venezuela, RB | 64 | 64 | 46 | 61 | 61.939 | 81.3 | 80.7 |
| Developing countries | Sub-Saharan Africa | Botswana | 63 | 69 | 43 | 59 | 73.993 | 0.0 | 74.4 |
| Developing countries | Sub-Saharan Africa | South Africa | 56 | 56 | 56 | 63 | 63.253 | 70.9 | 57.8 |
| Developing countries | MENA | Bahrain | 8 | 23 | 10 | 38 | 66.928 | 48.0 | 45.3 |
| Developing countries | MENA | Jordan | 43 | 49 | 28 | 49 | 90.857 | 90.4 | 55.1 |
| Developing countries | MENA | Kuwait | 15 | 43 | 45 | 55 | 58.099 | 47.0 | 52.1 |
| Developing countries | MENA | Qatar | 4 | 19 | 6 | 40 | 41.454 | 79.7 | 67.6 |
| Developing countries | MENA | Saudi Arabia | 6 | 15 | 2 | 43 | 40.724 | 64.8 | 49.0 |
| Developing countries | MENA | United Arab Emirates | 1 | 22 | 8 | 36 | 48.444 | 72.7 | 55.5 |
| Developed countries | OECD | Australia | 31 | 27 | 33 | 10 | 0 | 65.9 | 62.6 |
| Developed countries | OECD | Austria | 23 | 13 | 47 | 9 | 60.86 | 0.0 | 73.6 |
| Developed countries | OECD | Belgium | 7 | 6 | 15 | 18 | 60.463 | 56.7 | 81.8 |
| Developed countries | OECD | Canada | 50 | 26 | 22 | 11 | 7.83 | 62.1 | 60.8 |
| Developed countries | OECD | Chile | 58 | 66 | 41 | 44 | 57.382 | 80.2 | 61.1 |
| Developed countries | OECD | Colombia | 47 | 57 | 58 | 50 | 71.691 | 57.3 | 65.0 |
| Developed countries | OECD | Czechia | 37 | 16 | 20 | 25 | 54.821 | 0.0 | 92.5 |
| Developed countries | OECD | Denmark | 10 | 1 | 5 | 3 | 20.417 | 76.3 | 92.8 |
| Developed countries | OECD | Estonia | 36 | 26 | 21 | 23 | 48.24 | 87.5 | 96.1 |
| Developed countries | OECD | Finland | 52 | 9 | 17 | 5 | 49.161 | 87.9 | 85.1 |
| Developed countries | OECD | France | 27 | 21 | 62 | 14 | 53.774 | 65.7 | 68.8 |
| Developed countries | OECD | Germany | 19 | 18 | 44 | 7 | 66.971 | 74.0 | 79.2 |
| Developed countries | OECD | Greece | 24 | 45 | 38 | 34 | 61.241 | 65.8 | 81.2 |
| Developed countries | OECD | Hungary | 18 | 50 | 63 | 41 | 57.118 | 0.0 | 86.5 |
| Developed countries | OECD | Iceland | 55 | 17 | 3 | 2 | 53.022 | 62.8 | 54.4 |
| Developed countries | OECD | Ireland | 30 | 3 | 1 | 12 | 0 | 72.6 | 88.6 |
| Developed countries | OECD | Israel | 40 | 20 | 24 | 30 | 70.871 | 37.5 | 49.4 |
| Developed countries | OECD | Italy | 28 | 32 | 36 | 20 | 71.567 | 62.6 | 79.9 |
| Developed countries | OECD | Japan | 57 | 54 | 51 | 8 | 83.158 | 55.8 | 63.1 |
| Developed countries | OECD | Korea, Rep. | 42 | 41 | 18 | 29 | 69.833 | 55.4 | 54.1 |
| Developed countries | OECD | Latvia | 41 | 51 | 57 | 35 | 48.094 | 84.0 | 97.8 |
| Developed countries | OECD | Lithuania | 25 | 24 | 25 | 28 | 31.679 | 82.0 | 95.3 |
| Developed countries | OECD | Luxembourg | 12 | 14 | 26 | 22 | 43.711 | 0.0 | 67.7 |
| Developed countries | OECD | Mexico | 54 | 47 | 50 | 54 | 69.253 | 62.6 | 55.4 |
| Developed countries | OECD | Netherlands | 3 | 4 | 4 | 19 | 58.815 | 55.3 | 77.9 |
| Developed countries | OECD | New Zealand | 62 | 53 | 31 | 15 | 0 | 53.2 | 49.0 |
| Developed countries | OECD | Norway | 11 | 11 | 27 | 6 | 54.589 | 74.6 | 74.1 |
| Developed countries | OECD | Poland | 21 | 29 | 52 | 46 | 56.48 | 72.1 | 92.9 |
| Developed countries | OECD | Portugal | 26 | 35 | 36 | 27 | 71.464 | 49.4 | 73.9 |
| Developed countries | OECD | Slovak Republic | 38 | 34 | 61 | 37 | 68.485 | 0.0 | 89.2 |
| Developed countries | OECD | Slovenia | 9 | 28 | 53 | 32 | 68.355 | 71.3 | 83.6 |
| Developed countries | OECD | Spain | 13 | 30 | 48 | 21 | 57.897 | 59.5 | 66.4 |
| Developed countries | OECD | Sweden | 33 | 8 | 9 | 4 | 65.258 | 69.3 | 80.2 |
| Developed countries | OECD | Switzerland | 20 | 2 | 16 | 1 | 78.117 | 0.0 | 66.3 |
| Developed countries | OECD | Türkiye | 17 | 44 | 42 | 47 | 67.612 | 58.6 | 53.9 |
| Developed countries | OECD | United Kingdom | 34 | 33 | 37 | 13 | 70.551 | 76.1 | 86.2 |
| Developed countries | OECD | United States | 32 | 10 | 30 | 17 | 31.816 | 65.7 | 60.4 |