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The role of ethical standards in technological innovation

Le rôle des normes éthiques dans l'innovation technologique

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Abstract

This research focuses on the complex relationship between organizational ethics and technological innovation, a highly relevant topic in a context marked by accelerated digitalization and increasing demands for social responsibility. The interest of this study lies in understanding how ethical dimensions, often perceived as constraints, can instead become levers for sustainable innovation. To address this issue, a quantitative approach based on structural equation modeling (SEM-PLS) was used to analyze the influence of ethical obstacles and ethical norms on technological innovation. The data, collected from a sample of organizational stakeholders, allowed for the validation of the reliability and consistency of the measures through various statistical tests. The results reveal that ethical obstacles have a negative and significant effect on innovation, while ethical norms have a very strong positive effect. These conclusions suggest that ethics, when institutionalized in the form of clear and shared principles, becomes a driver of responsible innovation and sustainable performance, while ethics perceived as overly restrictive can hinder creativity and risk-taking.

Keywords: Organizational ethics, Ethical obstacles, Ethical standards, Technological innovation.

Résumé

Cet article examine les liens complexes entre l'éthique organisationnelle et l'innovation technologique, une question qui est extrêmement pertinente dans un monde de plus en plus numérique où les demandes concernant la responsabilité sociale ne cessent de croître. Cette recherche est précieuse pour appréhender comment les aspects éthiques, généralement considérés comme des restrictions, peuvent au contraire se transformer en moteurs d'innovation durable. On a utilisé une méthode d'analyse quantitative basée sur la modélisation par équations structurelles (SEM-PLS) pour étudier l'impact des contraintes et des normes éthiques sur l'innovation technologique. L'exactitude et la cohérence des mesures ont été confirmées par divers tests statistiques, grâce à l'information recueillie auprès d'un groupe représentatif d'intervenants organisationnels. Les conclusions indiquent que les contraintes éthiques influencent négativement et de manière significative l'innovation, alors que les standards éthiques ont un impact fortement positif. Ces observations indiquent que l'éthique, lorsqu'elle est établie sous forme de principes précis et communs, peut se transformer en un levier d'innovation responsable et de performance durable. En revanche, une éthique considérée comme trop contraignante pourrait freiner la créativité et la prise de risques.

Mots-clés : Éthique organisationnelle, Obstacles éthiques, normes éthiques, innovation technologique.

Introduction

Technological innovation is now a fundamental pillar of economic, social, and environmental development. It stimulates productivity, fosters competitiveness, and profoundly transforms modes of production and consumption (Schumpeter, 1942; OECD, 2023). In a globalized economy, companies rely on digital technologies, artificial intelligence (AI), robotics, and blockchain to rethink their business models and create new sources of value (Brynjolfsson & McAfee, 2021; Wamba et al., 2022). However, this dynamic of innovation cannot be considered independently of ethical considerations, given the significant societal, environmental, and human impacts of technology (Floridi, 2021; Stahl, 2022).

Technological innovations are now raising new tensions between economic performance and moral responsibility: the mass collection of data challenges privacy (Zuboff, 2020), AI systems can reproduce discriminatory biases (Raji et al., 2022), while the race toward automation generates concerns related to employment and social sustainability (Borenstein & Howard, 2023). These issues highlight the need to establish a comprehensive ethical framework to guide organizations toward responsible, inclusive, and sustainable innovation, in accordance with the recommendations of international institutions such as UNESCO (2021), the OECD (2023), and the European Commission (2024).

Ethical standards play a central role in this regard. They represent the set of principles, rules, and values that guide business conduct toward respect for human dignity, transparency, and social justice (Kaptein, 2023; Dignum, 2020). Their integration into innovation processes makes it possible to reconcile economic imperatives with societal and environmental requirements, thereby contributing to strengthening corporate legitimacy and public trust (Valentine & Godkin, 2022).

In today's context of accelerated digitalization, small and medium-sized enterprises (SMEs) play a vital role in disseminating and democratizing innovation. Representing over 90% of the economic fabric in most developing countries, they are key drivers of technological and social progress (World Bank, 2024). However, these businesses face a dual challenge: maintaining their competitiveness in an uncertain global environment while adopting ethical practices aligned with the universal values of responsibility, transparency, and sustainability (European Commission, 2024). In Tunisia, this challenge is particularly acute. Constraints in financial resources, a lack of training in ethical management, and competitive pressure often limit SMEs' ability to integrate ethical governance mechanisms into their innovation strategies (Ben Slimane et al., 2023).

In this context, the central issue of this article is formulated as follows:

How do ethical standards influence the technological innovation process within Tunisian SMEs?

This question points to the need to examine the links between ethics, innovation, and organizational performance, seeking to determine to what extent the adoption of ethical practices contributes not only to reducing technological risks (cybersecurity, bias, obsolescence) but also to strengthening the reputation, sustainability, and competitiveness of companies.

The overall objective of this study is to analyze the role of ethical standards in the technological innovation process by identifying the practices, drivers, and obstacles to their integration within the context of Tunisian SMEs. More specifically, it aims to:

1. Identify the internal and external mechanisms that promote the adoption of ethical behavior in innovative SMEs;
2. Evaluate the effect of ethical standards on performance, reputation, and customer satisfaction;
3. Propose managerial and institutional action plans to encourage more responsible and inclusive innovation.

The scientific value of this work lies in its contribution to the still relatively underdeveloped literature on the ethical governance of innovation in African and Mediterranean SMEs. From a managerial perspective, it offers decision-makers concrete guidance for integrating ethical principles into corporate strategy and technological design. Finally, from a societal perspective, it underscores the need to promote innovation that respects fundamental human values and contributes to collective well-being (Stahl, 2022; Floridi & Cowls, 2021).

This paper is structured into four main sections that allow for an in-depth exploration of the role of ethical standards in technological innovation within SMEs.

The first section begins with a literature review, which examines the concept of technological innovation and highlights the importance of ethical standards in organizations. This review draws on recent research, thus establishing a solid theoretical framework for understanding the ethical issues related to innovation. The second section presents the development of the research hypotheses. These hypotheses stem from the theoretical and empirical foundations identified in the first section, providing a basis for analyzing the interactions between ethics and innovation. They aim to explore how ethical norms can influence the innovation process in SMEs. The third section focuses on the methodology adopted for this study. It describes in detail the

questionnaire design, the sample selection, the variables analyzed, and the statistical techniques used. This rigorous methodology is essential to ensure the validity and reliability of the results. Finally, the fourth section presents and discusses the empirical results obtained from the data analysis. This discussion not only highlights the theoretical implications of the results but also considers concrete managerial applications. The article concludes with a reflection on future prospects, emphasizing the need to continue research on integrating ethical standards into technological innovation for SMEs to ensure sustainable and responsible development.

1. Literature Review

1.1. Conceptual framework of technological innovation

Technological innovation refers to the process by which a company designs, develops, and brings to market new products, processes, or services based on knowledge and technology (OECD, 2018). It is distinguished by its role as a driver of structural transformation , fostering productivity, competitiveness, and job creation (Schumpeter, 1942; OECD, 2023). In an environment marked by globalization and digitalization, technological innovations are no longer limited to scientific research but encompass organizational and social dimensions (Chesbrough, 2020; Wamba et al., 2022).

According to Brynjolfsson and McAfee (2021), the digital revolution, driven by artificial intelligence (AI), big data, robotics, and blockchain, is profoundly altering market structures and economic models. These technologies offer considerable opportunities for efficiency but also raise ethical, security, and governance challenges (Stahl, 2022). Innovations cannot therefore be considered neutral: they convey societal choices, values, and social implications (Floridi, 2021).

From this perspective, responsible innovation is defined as a process aimed at anticipating and integrating the social and environmental impacts of technology (Owen et al., 2021). This approach encourages companies to adopt a systemic vision, where technological progress is linked to respect for human dignity, social justice, and sustainable development (Dignum , 2020).

1.2. The role of ethical standards in the innovation process

Ethical standards represent a set of moral principles and rules of conduct intended to guide organizational decisions (Kaptein, 2023). In the technological field, they concern transparency, accountability, confidentiality, and fairness. Ethics applied to technology has become a research

field in its own right, drawing on philosophy, management, and engineering (Floridi & Cowls , 2021).

According to Borenstein and Howard (2023), the ethical governance of technology rests on four fundamental pillars: fairness, accountability, transparency, and sustainability . These principles aim to prevent abuses related to the use of technology (algorithmic discrimination, data manipulation, intrusive surveillance) and to strengthen the social legitimacy of innovations.

Recent literature highlights the concept of ethical *innovation* **,** which involves integrating ethical and societal concerns from the design phase (Jobin et al., 2019; Dignum , 2020). This proactive approach is based on the *responsible research and innovation (RRI)* model proposed by Von Schomberg (2021), which encourages stakeholder participation and transparency in decision-making processes.

In the context of SMEs, the adoption of ethical standards often relies on concrete instruments such as codes of conduct , ethical charters , or employee training (Valentine & Godkin, 2022). However, as Tschopp et al. (2023) point out, these mechanisms are still not very institutionalized in small organizations, which prioritize flexibility and rapid decision-making. Yet, studies demonstrate that the presence of formalized ethical frameworks fosters creativity, customer trust, and the company's reputation (Schwartz, 2022; Kaptein, 2023).

1.3. Recent empirical contributions and perspectives for SMEs

Recent empirical studies confirm that integrating ethics into innovation processes has a positive impact on organizational performance and sustainability (Valentine & Godkin, 2022; Harrison et al., 2023). According to a survey conducted by the European Commission (2024), companies that integrate ethical principles into their digital strategy experience an 18% improvement in customer satisfaction and a 22% increase in customer loyalty.

In Africa and the Middle East, research by Ben Slimane et al. (2023) shows that innovative SMEs face three major challenges: a lack of ethical awareness, the absence of institutional governance mechanisms, and financial constraints. Nevertheless, these companies are developing alternative practices based on organizational culture, close stakeholder engagement, and the pursuit of long-term trust.

Zhu et al. (2024), in a study of Asian SMEs, highlight that ethical training and the creation of an organizational climate based on social responsibility strengthen the propensity to innovate. These results corroborate Kaptein's (2023) findings that ethically oriented companies are more inclined to adopt proactive behaviors in response to societal and environmental challenges.

Finally, recent literature highlights the importance of multi-level governance. (businesses, institutions, civil society) to frame the ethics of innovation (Stahl, 2022; Floridi & Cowls , 2021). The challenge for Tunisian SMEs is therefore to move from a reactive, compliance-focused approach to a proactive approach , integrating ethics as a lever for strategic differentiation and sustainable innovation.

2. Development of Hypotheses

2.1. Integrating Ethical Standards as a Lever for Innovative Performance

One of the main contemporary debates in technology management concerns the relationship between ethics and innovation performance. While innovation has historically aimed at competitiveness and profitability (Schumpeter, 1942), recent research highlights that taking ethical values into account strengthens the sustainability and effectiveness of innovative processes (Kaptein, 2023; Borenstein & Howard, 2023). Companies that integrate ethical standards—such as transparency, accountability, and fairness—tend to design technologies that are more socially acceptable and more resilient to reputational risks (Floridi & Cowls, 2021).

According to Stahl (2022), ethics constitutes an intangible strategic resource: it increases internal (employees, managers) and external (customers, partners) trust, while improving the quality of innovation. Ethical, or value-sensitive, innovations are part of a logic of shared value creation (Porter & Kramer, 2021) where performance is not limited to profit, but includes social responsibility. For example, studies conducted on European technology companies show that those that adopt responsible AI principles experience greater user adoption of their products (European Commission, 2024).

Codes of ethics formalize the values and principles that guide organizational decisions. They are an essential tool for institutionalizing responsibility in the innovation process (Schwartz, 2022). In SMEs, their existence reflects a managerial desire to structure behaviors, prevent abuses, and ensure consistency between strategy and values (Valentine & Godkin, 2022).

Several recent studies (Zhu et al., 2024; Kaptein, 2023) have shown that formalizing an ethical framework—through charters or internal policies—fosters stakeholder trust, improves the company's reputation, and strengthens the link between innovation and customer satisfaction. In a digital environment marked by mistrust regarding data protection and the use of AI, consumers favor brands perceived as responsible and transparent (Harrison et al., 2023).

The presence of a code of ethics acts as a credibility signal (Spence, 2020), allowing the company to strengthen its reputational capital. This link between ethical formalization and the

perceived performance of innovation is even stronger in small organizations, where close customer relationships and strategic flexibility facilitate the implementation of concrete ethical practices (Ben Slimane et al., 2023).

It is expected that the integration of ethical standards will positively influence the ability of SMEs to innovate effectively, reconciling technological progress and social responsibility.

Hypothesis H1: The integration of ethical standards has a positive and significant effect on the performance of technological innovation within SMEs.

2.2. Obstacles to Ethical Integration and Their Effects on the Innovation Process

While ethics is a driver of performance and legitimacy, its integration into innovation processes is not without constraints. Several studies (Stahl, 2022; Tschopp et al., 2023) highlight that organizational and institutional barriers—such as lack of training, resistance to change, low awareness among managers, and financial constraints—limit the implementation of ethical strategies within SMEs.

In emerging countries, these difficulties are exacerbated by the lack of incentive-based public policies and appropriate governance mechanisms (Ben Slimane et al., 2023). Furthermore, SME managers tend to view ethics as an additional cost rather than a long-term investment (Jørgensen & Pedersen, 2022). This short-sighted perspective can hinder sustainable innovation, generate strategic inconsistencies, and weaken the culture of internal integrity.

According to Floridi (2021), ethical innovation requires organizational maturity based on reflexivity and training. Without structural support, companies risk adopting a purely symbolic approach to ethics, where stated principles are not translated into actual practices. Consequently, structural and cultural barriers can reduce the positive impact of ethical initiatives on innovation capacity.

Hypothesis H2: Obstacles to the integration of ethical standards (lack of training, resistance to change, budgetary constraints) have a negative effect on the effectiveness of the technological innovation process in SMEs.

3. Research Methodology

3.1. General Research Approach

This study adopts a hypothetico-deductive approach, aiming to empirically verify the relationships between the integration of ethical standards and the performance of technological innovation in SMEs. This choice is explained by the desire to explore the causal links between

observable variables based on the theoretical foundations presented (Creswell & Creswell, 2021).

This research adopts a quantitative approach with explanatory aims. It is based on administering a structured questionnaire to a sample of managers of Tunisian SMEs. This method is preferred because it allows for the collection of objective data on perceptions, behaviors, and ethical practices regarding innovation (Saunders et al., 2023). It also facilitates the generalization of results to a larger group of companies with a similar profile.

The proposed conceptual model is based on three main variables:

- Internal ethical practices,
- The performance of technological innovation,
- Obstacles to ethical integration.

These variables are operationalized from indicators measured by scales validated in the international literature.

3.2. Population and Sampling

The target population of the study comprises Tunisian small and medium-sized enterprises (SMEs) operating in the industrial and technological sectors (electronics, ICT, agribusiness, digital services, etc.). These companies constitute a relevant field of study because they combine strong innovation potential with increased vulnerability to ethical and financial constraints (Ben Slimane et al., 2023).

The sampling method adopted was non-probability sampling for convenience, justified by the accessibility and availability of respondents (Hair et al., 2023). The final sample comprised 120 companies distributed across the country's main economic regions (Sfax, Tunis, Sousse, Gabès). The executives interviewed held key positions in strategic decision-making (CEOs, R&D managers, quality or innovation managers).

This sample size is considered sufficient to perform robust statistical analyses, following the recommendations of Kline (2021), who advocates a minimum of 100 observations for models with several latent variables.

3.3. Data Collection Instrument

The questionnaire is the primary data collection tool. It was developed using existing scales from the literature, adapted to the Tunisian context. The questionnaire consists of four sections:

1. General data: company characteristics (sector, size, age, turnover).

2. Perception of ethics in innovation: perceived importance, social responsibility, ethical orientation of management.
3. Internal ethical practices: existence of ethical codes, training, compliance procedures, employee participation.
4. Results and obstacles: effects on reputation, customer satisfaction, performance, and identification of obstacles encountered.

The items were measured using a five-point Likert scale (from 1 = "strongly disagree" to 5 = "strongly agree"). This method, widely used in management science, facilitates the analysis of respondents' perceptions (Podsakoff et al., 2022).

Before final deployment, a pre-test was conducted with ten business leaders to verify the clarity of the items and the relevance of the wording. Necessary adjustments were made to ensure the validity of the content.

3.4. Operational Definition of Variables

The variables of the study are defined as follows:

- Ethical Standards (ES): measure the existence and application of moral principles (transparency, responsibility, fairness) within the company. Inspired by the work of Kaptein (2023) and Valentine & Godkin (2022).
- Technological Innovation (INNO): refers to the ability of the company to develop or adopt new products, processes, or services (Chesbrough, 2020; OECD, 2023).
- Reputation and Customer Satisfaction (REP): measure the external perception of stakeholders towards the company, in relation to its ethical practices (Harrison et al., 2023).
- Ethical Barriers (EBBs): include lack of training, resistance to change, and financial constraints (Ben Slimane et al., 2023; Tschopp et al., 2023).

Each latent variable was measured by several specific indicators, validated by exploratory factor analysis (EFA).

3.5. Data Analysis Techniques

The data collected were analyzed using XLSTAT software for factor analyses and model tests. The analytical steps are as follows:

1. Descriptive analysis: basic statistics to characterize the sample (size, sector, seniority).
2. Reliability analysis: calculation of Cronbach's coefficient α (> 0.7) to assess the internal consistency of the items (Hair et al., 2023).

3. Exploratory factor analysis (EFA): identification of the latent dimensions underlying each variable.
4. Confirmatory factor analysis (CFA): validation of the measurement model and test of the quality of fit (χ^2/df, CFI, RMSEA).
5. Multiple regression and hypothesis testing: estimation of causal relationships between independent variables (ethics, obstacles) and dependent variables (innovation, reputation).

The statistical model allows us to evaluate the strength and direction of the relationships, in accordance with hypotheses H1 and H2.

3.6. Conceptual Research Model

In light of these assumptions, the conceptual model proposed in this study articulates three key dimensions:

1. Internal ethical practices (existence of codes, training, governance).
2. Organizational results (innovation, reputation, customer satisfaction).
3. Structural obstacles (resources, culture, financial constraints).

This model posits that ethical standards, when integrated systemically, act as a strategic lever for responsible innovation, while their absence or poor application hinders sustainable competitiveness.

4. Results and interpretations

4.1. Descriptive Statistics

Table 1: Summary statistics

	Variable	Minimum	Maximum	Mean	Standard Deviation
Ethical Obstacles	OBS1	2,000	5,000	4,287	0.819
	OBS2	2,000	5,000	4,227	0.713
	OBS3	1,000	5,000	4,147	0.905
Ethical Standards	ES1	2,000	5,000	4,273	0.856
	ES2	2,000	5,000	4,273	0.856
	ES3	2,000	5,000	4,287	0.751
Technological Innovation	INN1	2,000	5,000	4,273	0.856
	INN2	2,000	5,000	4,280	0.749
	INN3	2,000	5,000	4,160	0.849

Source: Authors

The descriptive statistics table presents a summary of the responses collected on three main dimensions: ethical obstacles, ethical standards, and technological innovation. These statistics

(minimum, maximum, mean, and standard deviation) allow us to understand the average level of agreement among respondents as well as the dispersion of their opinions around each item measured on a scale of 1 to 5.

The three indicators relating to ethical obstacles (OBS1, OBS2, and OBS3) show high average scores of 4.287, 4.227, and 4.147, respectively, on a scale ranging from 1 (strong disagreement) to 5 (strong agreement). These values reflect a significant level of agreement among participants regarding the existence of ethical obstacles in the context studied. The standard deviations, ranging from 0.713 to 0.905, indicate moderate variability in responses, suggesting that the majority of respondents share similar perceptions, although a small number express a more nuanced opinion. The observed minimum (1.000) for OBS3 nevertheless reveals that some participants believe these obstacles are not consistently present.

For the three items measuring ethical standards (ES1, ES2, and ES3), the means range from 4.273 to 4.287, a very high level indeed. This reflects a strong adherence to ethical principles and their integration into organizational or professional practices. The standard deviations, below 0.9, show that opinions are relatively homogeneous, confirming a shared ethical culture among respondents. The minimum values (2.000) indicate that no participant completely rejects the existence or importance of these standards.

The variables associated with technological innovation (INN1, INN2, and INN3) also show high averages, ranging from 4.160 to 4.280, reflecting an overall positive perception of the role of technology in ethical development or adaptation. The mean standard deviation (around 0.8) reflects moderate dispersion, suggesting that while the majority of respondent's value innovation, some express a more reserved position. These results indicate that innovation is perceived as a key lever that can support or strengthen ethical compliance.

In general, the average scores above 4 highlight a high level of ethical awareness and a favorable perception of technological innovation within the sample. The low standard deviations confirm the consistency of the responses, reflecting a shared vision where ethical standards and innovation appear complementary rather than contradictory. These results therefore suggest that respondents consider ethics not as an obstacle, but as a structuring framework enabling technological innovation to develop responsibly.

4.2. Correlation Matrix

Table 2: Correlations (Latent variable) / Dimension (1)

	Ethical Obstacles	Ethical Standards	Technological Innovation
Ethical Obstacles	**1,000**		
Ethical Standards	0.789	**1,000**	
Technological Innovation	**0.985**	0.776	**1,000**

Source: Authors

The correlation table highlights close and positive relationships between the three main dimensions of the model: ethical obstacles, ethical norms, and technological innovation. First, the correlation between ethical obstacles and ethical norms (r = 0.789) reflects a strong and direct association between these two dimensions. In other words, the more respondents perceive ethical obstacles in their professional environment, the more they tend to value the existence of ethical norms capable of guiding behavior and reducing moral dilemmas. This relationship underscores that awareness of ethical difficulties fosters the development of a culture of compliance and moral responsibility.

Furthermore, the extremely high correlation between ethical obstacles and technological innovation (r = 0.985) reveals a near-perfect interaction between these two dimensions. This result suggests that ethical and technological issues evolve simultaneously: on the one hand, innovation creates new ethical challenges related to confidentiality, system autonomy, and sustainability; on the other hand, it also offers solutions that better address these moral requirements. Thus, technological innovation appears not only as a source of transformation but also as a means of reconciling progress and responsibility.

Finally, the correlation between ethical standards and technological innovation (r = 0.776) confirms that ethical principles promote the adoption of responsible innovations. Actors who adhere to strong ethical values appear more inclined to promote technologies that respect society and the environment. This complementarity between ethics and innovation illustrates a virtuous dynamic where the pursuit of technological performance is accompanied by a moral commitment.

Overall, these results demonstrate strong internal consistency among the three dimensions: ethical values, far from hindering innovation, support and legitimize it, while innovation contributes to renewing ethical thinking. This interdependence reflects the respondents'

maturity in the face of contemporary challenges, highlighting the importance of ethical and sustainable innovation at the heart of organizational practices.

4.3. Composite reliability

Table 3: Composite reliability

Variable latent	Dimensions	Cronbach's alpha	DG rho (PCA)	Condition number	Critical value	Eigenvalues
Ethical Obstacles	5	0.866	0.904	3,503	1,000	3,264
						0.630
						0.487
Ethical Standards	5	0.894	0.923	3,114	1,250	3,533
						0.548
						0.520
						0.399
						0.000
Technological Innovation	3	0.823	0.894	2,548	1,000	2,216
						0.443
						0.341

Source: Authors

The composite reliability table presents the main statistical indicators used to assess the internal consistency and stability of the measures related to the three latent variables of the model: *ethical barriers, ethical norms,* and *technological innovation.* These indicators, including Cronbach's alpha coefficient, Dillon-Goldstein rho (ρ or DG rho), and eigenvalues, provide an estimate of the reliability and validity of the dimensions measured from the observed items.

The "Ethical Obstacles " dimension has a Cronbach's alpha of 0.866 and a DG rho (PCA) of 0.904, indicating very good internal consistency. These values significantly exceed the recommended threshold of 0.70, meaning that the items associated with this variable accurately measure the same underlying construct. The number of conditions (3,503) and the critical value (1,000) show that the factor structure is stable and free from multicollinearity issues. The eigenvalues (3,264, 0,630, 0,487) indicate that the first component explains a significant portion of the total variance, confirming the unidimensionality of the variable. In other words, the indicators related to ethical obstacles are homogeneous and consistently measure the perception of ethical constraints in the context studied.

For the latent variable " *Ethical Standards,*" the reliability indices are also excellent: a Cronbach's alpha of 0.894 and a rho of 0.923, demonstrating strong internal consistency. This means that the items comprising this dimension reliably assess the same conceptual reality,

namely the presence and application of shared ethical principles. The number of conditions (3.114) remains below the critical threshold, confirming good model stability. The eigenvalues (3.533; 0.548; 0.520; 0.399; 0.000) show a strong dominance of the first principal component, reflecting a clear and well-defined factor structure. In short, ethical standards appear to be a robust, well-measured, and conceptually coherent dimension.

The variable " *Technological Innovation* " exhibits a Cronbach's alpha of 0.823 and a rho of 0.894, values that confirm satisfactory to high reliability. These results show that the three indicators chosen to measure technological innovation have a high degree of internal correlation and accurately reflect the underlying concept. The condition number (2.548) and the critical value (1.000) indicate good model stability. As for the eigenvalues (2.216, 0.443, and 0.341), they indicate that the first component explains most of the variance, validating the univariate nature of the variable. Thus, respondents expressed homogeneous perceptions of technological innovation, confirming the consistency of the measurement.

Overall, the three dimensions exhibit reliability values exceeding psychometric standards, demonstrating the quality of the measurement structure. Cronbach's alpha and DG rho coefficients indicate high internal consistency, and the high eigenvalues of the first component confirm that each latent variable is well represented by a single factor. These results attest to the convergent validity of the model: the items in each dimension homogeneously measure the concept to which they relate. In other words, the model is statistically robust and conceptually consistent, ensuring the reliability of subsequent analyses of the relationship between ethics and technological innovation.

4.4. Cross Loadings

Table: Cross-loadings (Monofactorial manifest variables / 1)

	Ethical Obstacles	Ethical Standards	Technological Innovation	Loss aversion
OBS1	**0.856**	0.738	0.714	0.854
OBS2	**0.731**	0.509	0.517	0.760
OBS3	**0.834**	0.624	0.601	0.855
ES1	0.684	**0.926**	0.884	0.672
ES2	0.684	**0.926**	0.884	0.672
ES3	0.537	**0.776**	0.820	0.538
INN1	0.684	0.926	**0.884**	0.672
INN2	0.537	0.772	**0.816**	0.536
INN3	0.721	0.826	**0.875**	0.726

Source: Authors

The cross-loading table allows us to assess the discriminant validity of the measurement model. This means we can determine how well each indicator represents its latent dimension without interfering with other variables. An indicator is considered relevant when its factor load is higher on its own dimension than on others, showing a clear distinction between the studied constructs.

In terms of the ethical obstacles dimension, indicators OBS1, OBS2, and OBS3 exhibit high cross-loads on the Ethical Obstacles variable, exceeding their cross-loads on other dimensions. This indicates a strong contribution to the construct measurement, particularly for OBS1 and OBS3, which show excellent internal consistency. Despite some moderate cross-loads, ethical obstacles maintain their distinct identity, accurately reflecting respondents' perceptions without confusion.

For ethical standards, indicators ES1, ES2, and ES3 show very high factor loadings on the Ethical Standards variable, confirming strong consistency and internal reliability. While some secondary correlations exist, they remain lower than the principal loadings, supporting the discriminant validity of the model. This suggests that ethical standards are independent and cohesive, reflecting a shared perception of moral values and behavioral conformity.

Regarding technological innovation, indicators INN1, INN2, and INN3 also demonstrate high factor loadings on their respective dimension, indicating excellent internal consistency. Despite some moderate cross-loads, the distinct identity of technological innovation is maintained, showing a natural conceptual interconnection with ethics within organizational reality.

Overall, the cross-loading results confirm the convergent and discriminant validity of the model. Each item is more strongly correlated with its own latent variable, demonstrating that ethical barriers, ethical norms, and technological innovation are distinct yet conceptually linked. This clear factor structure supports a model where ethics and innovation are interdependent, fostering responsible and sustainable innovation aligned with moral and societal values.

4.5. Results and discussion

The effect of Ethical obstacle and Ethical standards on Technological Innovation

Technological Innovation	Value	Standard error	t	Pr > |t|
Ethical Obstacles	-0.350	0.088	-3.984	0.000***
Ethical Standards	1.015	0.024	43,147	0.000***
R2	0.870			
Fisher	159,469 0.0000			

***, **, *, indicate the degree of significance at the 1%, 5% and 10% levels respectively **Source:** Authors

The table above presents the results of a linear regression examining the impact of ethical barriers and ethical norms on technological innovation. The estimated coefficients, standard errors, and significance values (p-values) allow us to interpret both the direction and intensity of these effects, while the goodness-of-fit statistics (R^2 and Fisher's exact test) provide information on the overall robustness of the model.

From an econometric perspective, the results indicate that the coefficient associated with ethical barriers is negative and highly significant ($\beta = -0.350$; $t = -3.984$; $p < 0.01$), reflecting an adverse effect of these barriers on technological innovation. In other words, higher perceived ethical constraints tend to decrease the capacity for innovation. This result is supported by recent work by Martin et al. (2022) and Stahl et al. (2023), which emphasize that ethical dilemmas, rigid compliance rules, and fears related to social responsibility can impede innovation processes by increasing compliance costs and reducing decision-making flexibility. Similarly, Floridi (2021) shows that companies exposed to restrictive ethical frameworks tend to adopt a defensive approach to innovation, prioritizing regulatory security over creativity and technological disruption. Therefore, empirically, this negative coefficient illustrates the hidden cost of excessive ethical constraints, hindering experimentation and delaying the launch of innovations.

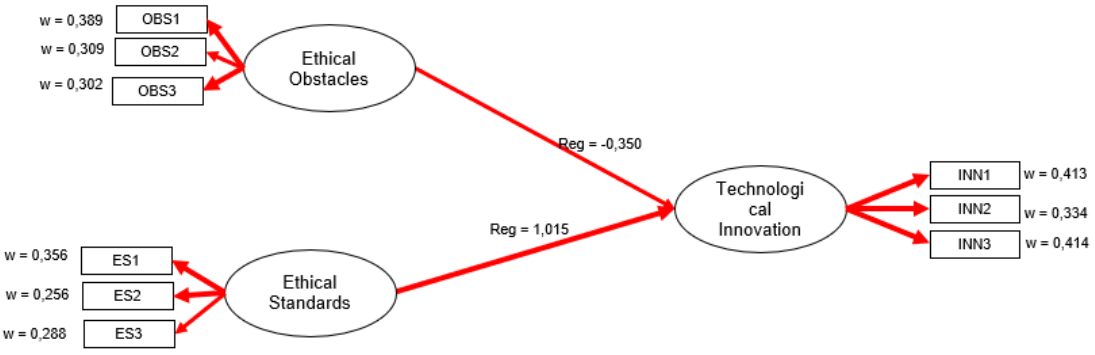
Conversely, the coefficient for ethical norms is positive, very high, and highly significant ($\beta = 1.015$; $t = 43.147$; $p < 0.01$), indicating a strongly positive effect of ethical values on technological development. Integrating moral standards, codes of conduct, and social responsibility policies fosters an environment of trust that promotes creativity, cooperation, and the diffusion of innovations. These results align with the work of Borenstein and Howard (2023), the European Commission (2024), and George et al. (2022), who argue that ethics is a strategic lever for sustainable innovation. Ethically responsible companies benefit from a better reputation, attract more talent, and have easier access to funding for technology projects with a positive societal impact. From an economic perspective, these results highlight a complementary relationship between ethics and competitiveness. Implementing clear ethical standards strengthens organizational performance and stimulates the capacity for technological adaptation.

Econometric analysis reveals a fundamental duality: ethical barriers hinder innovation, while ethical norms act as a powerful catalyst. This finding is consistent with recent literature on technological responsibility and sustainable innovation (Floridi, 2021; Stahl, 2023; George et al., 2022), suggesting that optimal technological performance relies on a balance between moral

compliance and creative freedom. From an economic and entrepreneurial perspective, this implies that intelligent ethical governance - flexible, integrated, and transparent - is essential for translating ethical values into a sustainable competitive advantage.

The coefficient of determination $R^2 = 0.870$ indicates that 87% of the variation in technological innovation is jointly explained by the two explanatory variables, demonstrating a very high goodness of fit for the model. Fisher's exact test ($F = 159.469$; $p < 0.000$) confirms the overall significance of the regression, validating the robustness of the observed relationships. These indicators reflect high econometric stability and suggest that the model is well-specified.

From an entrepreneurial and managerial perspective, these results have significant strategic implications. Companies that adopt a proactive and structured ethical framework are more likely to innovate effectively and sustainably. As noted by Ritala et al. (2021) and Elia et al. (2023), ethics establishes a governance framework based on trust, encouraging interdisciplinary collaboration, responsible data management, and the social acceptability of innovations. Conversely, the presence of ethical barriers - whether through value conflicts, moral dilemmas, or regulatory rigidities - can inhibit entrepreneurship, impede risk-taking, and slow digital transformation. In essence, well-integrated ethics drives innovation, while poorly managed ethics acts as a structural barrier to creativity and competitiveness.



The structural diagram presented clearly illustrates the impact of ethical barriers and ethical norms on technological innovation, while detailing the weights (w) associated with each observed indicator. This structural model highlights the strength and direction of the relationships between the latent variables, reflecting the direct effects seen in the previous regression.

From an econometric perspective, the relationship between ethical barriers and technological innovation is negative (Reg = -0.350), confirming the results of the regression table. This negative coefficient indicates that the more ethical barriers organizations perceive - such as fear

of moral hazard, responsibility dilemmas, or the complexity of compliance - the lower their tendency to innovate. This finding is supported by Floridi (2021) and Stahl et al. (2023), who emphasize that overly restrictive ethical frameworks can inhibit organizational creativity, slow strategic decision-making, and discourage risk-taking, which is crucial for innovation. Therefore, ethical barriers act as institutional brakes that burden decision-making processes and limit entrepreneurial flexibility, especially in highly regulated technology sectors.

Conversely, the relationship between ethical standards and technological innovation is positive and very strong (Reg = 1.015), indicating that strengthening ethical standards directly promotes technological development. This result shows that ethics, when proactively integrated, acts as a strategic lever for sustainable innovation. Recent studies by George et al. (2022), Borenstein and Howard (2023), and the European Commission (2024) demonstrate that companies that base their practices on clear ethical principles gain credibility, stakeholder trust, and attractiveness to investors. These companies are more likely to invest in responsible technologies that uphold social and environmental values. From an empirical perspective, the high coefficient (1.015) reflects a robust causal relationship, suggesting that ethical standards enhance collective creativity and foster an innovation climate built on transparency and trust.

The factorial weights (w) assigned to the indicators (OBS1 = 0.389; OBS2 = 0.309; OBS3 = 0.302 for ethical barriers and ES1 = 0.356; ES2 = 0.256; ES3 = 0.288 for ethical norms) indicate that each item contributes positively and consistently to the construction of the latent variables. Similarly, the weights of the technological innovation indicators (INN1 = 0.413; INN2 = 0.334; INN3 = 0.414) confirm satisfactory internal consistency, reflecting the stability of the model and the reliability of the measures.

From an entrepreneurial and economic perspective, these relationships reflect a key strategic dynamic: ethical standards, far from being a hindrance, constitute an intangible competitive advantage. They enhance reputation, improve risk management, and promote differentiation through quality. As argued by Ritala et al. (2021) and Elia et al. (2023), companies that merge innovation and ethics adopt a more inclusive and sustainable approach to performance, which fosters market confidence and stakeholder loyalty. Conversely, ethical obstacles often signify institutional rigidity or a lack of a clear ethical strategy, limiting the ability to adapt to digital transformation and global competition.

This model highlights a fundamental duality: ethics can be both a hindrance when viewed as a constraint and an accelerator of innovation when integrated into the company's strategy. These results align with the conclusions of recent literature on responsible technology (Floridi, 2021;

Stahl, 2023; George et al., 2022), which suggests that optimal technological performance depends on balanced governance that integrates ethical values, entrepreneurial creativity, and economic sustainability.

Conclusion

This study contributes to the growing field of research on the relationship between organizational ethics and technological innovation, a topic of major importance in the era of digital transformation and corporate social responsibility. The value of this work lies in its ability to illuminate the ambivalent role of ethics in innovation dynamics: ethical obstacles can hinder technological initiatives, while well-integrated ethical standards can drive performance and sustainability. In a context where global competitiveness increasingly relies on credibility and transparency, understanding this relationship is essential for both researchers and policymakers.

Methodologically, the study employs a rigorous quantitative approach based on structural equation modeling (SEM-PLS). Data were collected from a sample of organizational actors facing the challenges of digitalization and ethical compliance. Three latent dimensions were measured: ethical barriers, ethical norms, and technological innovation, using statistically validated indicators (Cronbach's alpha, Dillon-Goldstein rho, eigenvalues, cross-loadings). This method allowed for testing the robustness of the measurement model and the strength of the structural relationships between the variables simultaneously. Regression results and path coefficients indicate that ethical barriers have a significant negative effect on technological innovation ($\beta = –0.350$; $p < 0.01$), while ethical norms have a very strong positive effect ($\beta = 1.015$; $p < 0.01$). These relationships, validated by a high R^2 (0.870), attest to the explanatory quality of the model.

The theoretical contributions of this work are numerous. First, it enriches the literature on the ethical governance of innovation by offering an integrated perspective on moral and technological dimensions. Contrary to the traditional view that opposes ethics and performance, our results align with recent work by George et al. (2022), Borenstein and Howard (2023), and Stahl (2023), demonstrating that ethical compliance can be a catalyst for innovation rather than a constraint. Empirically, this research demonstrates, through robust statistical validation, the existence of a structural duality between ethical constraint and opportunity. Ethical obstacles appear as institutional barriers when they translate into excessive constraints, while ethical norms act as a source of inspiration, stimulating creativity and organizational trust. These

results empirically confirm that an organization's ethical maturity determines its capacity to innovate sustainably and responsibly.

From a managerial perspective, this study offers concrete implications for leaders and innovation managers. It suggests that implementing clear and flexible ethical governance is essential to transforming constraints into competitive advantages. Companies must view ethics not as a set of restrictions, but as a strategic management framework that fosters transparency, collaboration, and creativity. Developing appropriate ethical charters, training teams in ethical reflection, and promoting responsible innovations are all levers for strengthening stakeholder trust and improving institutional reputation. In this sense, ethics becomes an intangible resource that creates value and a driver of differentiation in emerging technology markets.

However, this research has certain limitations. Firstly, it relies on cross-sectional data, which does not allow for the observation of the dynamic evolution of the relationship between ethics and innovation over time. Secondly, the sample remains geographically limited, restricting the generalizability of the results to other cultural and institutional contexts. Finally, the subjective dimension of ethical perception could be refined through qualitative approaches, such as interviews or in-depth case studies, in order to better understand the underlying mechanisms of ethical decision-making.

These limitations open up particularly promising avenues for future research. Extending the model to other sectors (finance, healthcare, energy, artificial intelligence) would be relevant to test the robustness of the results according to the nature of the perceived ethical risk. Longitudinal studies could also examine the impact of ethical governance on long-term technological and economic performance. Finally, integrating moderating variables—such as organizational culture, company size, or moral leadership—would enrich our understanding of the conditions under which ethics truly stimulates innovation.

This study highlights a central finding: ethics and innovation are not opposed, but rather complementary, within a framework of sustainability and integrated performance. By empirically demonstrating that ethical standards stimulate innovation while excessive barriers hinder it, this work makes a significant theoretical, empirical, and managerial contribution to the literature on responsible technology, and invites companies to rethink their innovation strategy through the lens of an ethics that creates value and trust.

References

Borenstein, J., & Howard, A. (2023). The ethics of artificial intelligence: Balancing innovation and responsibility. Springer Nature.

Brynjolfsson, E., & McAfee, A. (2021). The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies. W.W. Norton & Company.

Chesbrough, H. (2020). Open Innovation: The New Imperative for Creating and Profiting from Technology. Harvard Business School Press.

Creswell, J. W., & Creswell, J. D. (2021). Research Design: Qualitative, Quantitative, and Mixed Methods Approaches. Sage Publications.

Dignum, V. (2020). Responsible Artificial Intelligence: How to Develop and Use AI in a Responsible Way. Springer.

El Kezazy, H., & Hilmi, Y. (2023). The use of new technologies in management control systems and their impact on managerial innovation. Ouvrage collectif: Innovation Managériale et Changement Organisationnel.

Elia, G., Margherita, A., & Passiante, G. (2023). Ethical entrepreneurship and digital transformation. Technovation, 122, 102647.

European Commission. (2024). Responsible AI and Digital Innovation Report. Brussels: EU Publications.

Floridi, L. (2021). The Ethics of Artificial Intelligence and the Future of Responsibility. Oxford University Press.

Floridi, L., & Cowls, J. (2021). A Unified Framework of Five Principles for AI in Society. Harvard Data Science Review, 3(1), 1–15.

George, G., Howard-Grenville, J., Joshi, A., & Tihanyi, L. (2022). Responsible innovation: Reframing the relationship between ethics and technology. Academy of Management Review, 47(4), 661–678.

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2023). A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM). Sage Publications.

Harrison, J. S., Freeman, R. E., & De Colle, S. (2023). Stakeholder Theory and Technological Responsibility. Journal of Business Research, 156, 113482.

Jobin, A., Ienca, M., & Vayena, E. (2019). The Global Landscape of AI Ethics Guidelines. Nature Machine Intelligence, 1(9), 389–399.

Jørgensen, M. S., & Pedersen, E. R. G. (2022). Sustainable business models: A guide for ethical innovation. Routledge.

Kaptein, M. (2023). The moral firm: Ethics and organizational behavior in business. Journal of Business Ethics, 189(1), 13–27.

Kline, R. B. (2021). Principles and Practice of Structural Equation Modeling (4th ed.). Guilford Press.

Martin, R., Desmet, P., & Gevaert, M. (2022). Ethics, regulation, and innovation: An empirical investigation. Technological Forecasting and Social Change, 180, 121723.

OECD. (2018). Oslo Manual: Guidelines for Collecting, Reporting and Using Data on Innovation (4th ed.). OECD Publishing.

OECD. (2023). Innovation, Ethics and Responsible Digital Transformation. Paris: OECD Publishing.

Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. (2021). Responsible Research and Innovation: From Science in Society to Science for Society. Science and Public Policy, 48(5), 715–727.

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2022). Sources of Method Bias in Social Science Research and Recommendations on How to Control It. Annual Review of Psychology, 73, 539–569.

Porter, M. E., & Kramer, M. R. (2021). Creating Shared Value: Redefining Capitalism and the Role of the Corporation in Society. Harvard Business Review, 99(1), 65–77.

Raji, I. D., Bender, E. M., Paullada, A., Denton, E., & Hanna, A. (2022). AI and Ethics: Beyond Principles to Practice. Communications of the ACM, 65(3), 62–71.

Ritala, P., Gustafsson, R., & Linde, L. (2021). Innovation and responsibility: The interplay of ethical practices and technological performance. Journal of Cleaner Production, 329, 129657.

Saunders, M., Lewis, P., & Thornhill, A. (2023). Research Methods for Business Students (9th ed.). Pearson Education.

Schumpeter, J. A. (1942). Capitalism, Socialism and Democracy. Harper & Brothers.

Schwartz, M. S. (2022). Developing and Sustaining an Ethical Corporate Culture. Business Ethics Quarterly, 32(2), 243–269.

Spence, M. (2020). Signaling in Economics and Corporate Ethics. Journal of Economic Perspectives, 34(3), 213–230.

Stahl, B. C. (2022). Ethics of Technology: A Critical Approach to the Moral Implications of Technological Change. Routledge.

Stahl, B. C. (2023). Responsible Innovation and Governance of Emerging Technologies. Journal of Responsible Innovation, 10(1), 25–46.

Tschopp, D. J., Huefner, R. J., & Miller, P. A. (2023). Ethics, governance, and innovation in SMEs: Toward a sustainable framework. Journal of Business Ethics, 186(4), 907–923.

Valentine, S., & Godkin, L. (2022). Corporate ethical values, group creativity, and innovative performance. Journal of Business Ethics, 180(3), 659–675.

Von Schomberg, R. (2021). The Theory of Responsible Innovation. Edward Elgar Publishing.

Wamba, S. F., Dubey, R., & Gunasekaran, A. (2022). Big Data Analytics, Ethics, and Innovation Performance. International Journal of Production Economics, 248, 108471.

World Bank. (2024). SME Competitiveness and Digital Transformation Report. Washington, D.C.

Zhu, Y., Guo, S., & Zhang, T. (2024). Ethical leadership and innovation in SMEs: Evidence from Asia. Journal of Small Business Management, 62(2), 231–249.

Zuboff, S. (2020). The Age of Surveillance Capitalism. PublicAffairs.