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Research on the Necessity, Significance and Practical Path of Engineering Ethics from the Perspective of Industrial Engineering and Management

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Abstract: Against the backdrop of deep advancement of Industry 4.0 and intelligent manufacturing, Industrial Engineering and Management (IEM), as a core discipline that optimizes production systems, integrates supply chain resources and improves human factors efficiency, has expanded its practical boundary from pure technical optimization to the coordination of interests among multiple stakeholders. Nevertheless, numerous enterprises ignore engineering ethical norms in the implementation of industrial engineering, triggering a series of problems including labor safety accidents, unfair supply chain operation and impaired occupational health of frontline workers. Taking three core fields of IEM, namely production system optimization, supply chain management and human factors engineering, as research entry points, this paper combines typical cases of ethical misconduct to analyze specific manifestations and negative impacts caused by the absence of engineering ethics. On this basis, it systematically demonstrates the internal necessity of integrating engineering ethics into IEM practices: engineering ethics acts as a fundamental defense line for enterprises to avoid legal risks and safeguard the legitimate rights and interests of all stakeholders, as well as an essential prerequisite for enterprises to achieve long-term sustainable development. Meanwhile, this paper elaborates the multi-dimensional values of engineering ethics from enterprise, industry and social levels, and ultimately constructs a three-dimensional implementation system consisting of "university curriculum reform, establishment of enterprise ethical governance mechanisms and improvement of industrial norms". The study reveals that engineering ethics is not an additional requirement for IEM, but a core standard running through the whole process of system optimization, resource allocation and human factor design, which plays a pivotal role in promoting high-quality development of industrial engineering discipline and the sustainable transformation and upgrading of manufacturing industry.

Keywords: Industrial Engineering and Management; Engineering Ethics; Production System Optimization; Supply Chain Ethics; Human Factors Engineering; Practical Path.

1. Introduction

In recent years, global climate has undergone remarkable changes with frequent extreme meteorological disasters, and the manufacturing industry is accelerating its transformation toward intelligent and green manufacturing. Originating from Taylor's scientific management theory in the early 20th century, industrial engineering aims to achieve maximum output with minimum input, covering business segments including production process reconstruction, collaborative supply chain scheduling, human factors efficiency improvement and quality control. Along with industrial upgrading, IEM practices have evolved from traditional technology-driven optimization to comprehensive coordination balancing the demands of multiple parties, which requires coordinating enterprise cost efficiency, physical and mental health of employees, rights and interests of upstream and downstream suppliers, public interests and ecological environmental protection demands.

However, a number of ethical misconduct incidents in IEM practices in recent years have fully exposed industry deficiencies. In 2022, to boost output, the industrial engineering department of an auto parts manufacturer extended working hours and simplified safety operation procedures, resulting in a serious mechanical injury accident caused by fatigued workers, with direct economic losses exceeding 5 million RMB. In 2023, during the pandemic, the IEM team of an e-commerce platform optimized distribution links by prioritizing high-profit goods, delaying the delivery of medical supplies for daily use, which triggered public doubts and led to government regulatory interviews. In 2021, an electronic OEM factory adjusted assembly line workstations via industrial engineering while ignoring basic human factors engineering principles; long-term intensive bending work led over 30% of frontline workers to develop lumbar occupational diseases, plunging the enterprise into class-action lawsuits and brand crises.

The above cases reflect a core contradiction: current IEM practices generally lack ethical consideration. When industrial engineers solely take maximum efficiency and minimum cost as exclusive goals while ignoring ethical responsibilities toward employees, suppliers and the public, they will not only trigger administrative penalties and huge economic losses, but also continuously erode industrial reputation and public trust. Therefore, re-clarifying the intrinsic value of engineering ethics in the field of IEM has become an urgent demand for industrial practice and disciplinary development.

1.1. Research Significance

1.1.1. Theoretical Significance

Existing research on engineering ethics mostly focuses on physical construction disciplines such as civil engineering and mechanical engineering, while studies targeting system optimization disciplines like IEM are fragmented, lacking a complete theoretical framework adapted to industrial practices. This paper integrates classic engineering ethics theories including utilitarianism, deontology and virtue ethics with three core IEM scenarios, sorts out ethical conflicts under various scenarios, fills the research gap of specialized engineering ethics for industrial engineering, and provides references for subsequent theoretical exploration.

1.1.2. Practical Significance

Combined with real cases, this paper sorts out various hazards caused by the absence of ethics, which can provide a complete list of ethical risk identification for enterprise industrial engineering departments. The three-dimensional practical paths proposed in this paper can be directly applied to teaching reform of industrial engineering majors in universities, construction of internal ethical management systems in enterprises and improvement of unified industrial norms. They help practitioners balance efficiency targets and ethical bottom lines in system optimization, reduce various ethical misconduct incidents, and facilitate the ethical and sustainable transformation of manufacturing industry.

1.2. Research Methods and Framework

1.2.1. Research Methods

Case Analysis: Typical ethical misconduct cases in production, supply chain and human factors engineering fields in recent years are selected to deeply dissect manifestations, causes and chain consequences of ethical absence.

Literature Research: Literature on basic engineering ethics theories and existing industrial engineering industry studies is reviewed to build an analytical framework linking engineering ethics and IEM practices.

Logical Deduction: Essential values of engineering ethics are extracted from cases, its important functions are deduced from enterprise, industry and social layers, and a complete implementation path is formed in the end.

1.2.2. Paper Framework

This paper consists of six main parts: Introduction (research background, significance, methods) → Analysis of cases lacking engineering ethics in core IEM fields → Demonstration of necessity of integrating engineering ethics into IEM → Elaboration on multi-level values of engineering ethics → Three-dimensional practical paths for engineering ethics implementation → Conclusions and Prospects.

2. Case Analysis of Absent Engineering Ethics in Core Fields of Industrial Engineering and Management

IEM practices revolve around five key elements: man, machine, material, method and environment. Ethical conflicts mainly lie in three groups of contradictions: efficiency vs. human rights, cost vs. fairness, and production capacity vs. safety. This section analyzes unethical behaviors and derivative hazards in detail based on typical cases of three core fields.

2.1. Production System Optimization: Impaired Labor Rights under Efficiency-Oriented Logic

Production system optimization is the fundamental work of industrial engineering, which boosts output via process reengineering, cycle time adjustment and resource allocation. Nevertheless, some enterprises adopt a single "efficiency-first" orientation, ignoring workers' labor rights and operational safety and triggering severe ethical crises.

Case 1: Safety Accident Caused by Production Boost Optimization in an Auto Parts Enterprise in 2022

As a supporting manufacturer of engine parts for domestic vehicle manufacturers, the enterprise faced a surge in orders requiring monthly output to rise from 50,000 to 70,000 pieces. Without considering human physiological limits and equipment load limits, the industrial engineering department carried out three optimization measures: extending daily working hours from 8 to 10 hours and canceling lunch breaks; cutting production line tact time from 60 seconds to 45 seconds per piece and eliminating operation buffer time; reducing daily equipment safety inspections from three times to once to cut non-production hours.

Unethical Behaviors: Violating the principle of non-maleficence. Long working hours and tight tact time led to persistent worker fatigue, while hidden equipment hazards could not be eliminated in a timely manner. Workers' right to rest was infringed through forced overtime with overtime pay failing to meet the standards of the Labor Law of the People's Republic of China.

Consequences of the Incident: In the third week after implementation, a worker's hand was caught in a machine tool due to fatigue operation and suffered severe injury. The human resources and social security bureau imposed a fine of 200,000 RMB on the enterprise. Workers staged a three-day collective strike causing order delays, and the enterprise paid 3 million RMB in liquidated damages to vehicle manufacturers, with its brand reputation severely damaged.

Case Analysis: In this optimization project, industrial engineers only targeted output fulfillment without fulfilling professional obligations to guarantee workers' life safety and legal labor rights. The 2 million RMB additional revenue brought by short-term production increase was far less than the over 3.2 million RMB losses arising from accident fines, compensation and production shutdown, while the trust between workers and the enterprise was completely broken.

2.2. Supply Chain Management: Lack of Fairness and Social Responsibility under Cost Control

Supply chain optimization serves as a core module of industrial engineering. Engineers reduce total supply chain costs via supplier screening, inventory allocation and distribution coordination. However, some optimization schemes blindly cut costs, squeeze upstream and downstream partners and ignore rigid livelihood demands, violating the principle of justice and corporate social responsibility.

Case 2: Livelihood Security Crisis Arising from Distribution Optimization of an E-commerce Platform in 2023

During a regional sudden pandemic, local government required e-commerce platforms to prioritize the distribution of livelihood supplies including medicines, maternal and infant products and food. Centered on maximizing distribution profit, the IEM team of the platform formulated an optimization scheme: distributing electronic products and luxury goods first by sorting delivery priorities based on commodity profit margins, while delaying emergency medicine delivery. Third-party distributors were forced to shorten delivery hours without additional pandemic subsidies, leading most distributors to refuse orders of low-profit livelihood goods.

Unethical Behaviors: Violating the principle of justice by putting commercial gains above people's basic survival demands, resulting in chronic disease patients being cut off from medicines for 2 to 3 days. Distributors bore unilateral increased operational burdens without risk sharing, making the cooperation model fundamentally unfair.

Consequences of the Incident: Mass online complaints from the public led to government interviews with the platform, which was ordered to publicly rectify and apologize and fined 500,000 RMB. Orders of livelihood categories declined by 30%, and the enterprise later invested 2 million RMB to rebuild the livelihood supply chain for public trust restoration.

Case Analysis: The core of supply chain optimization lies in multi-stakeholder interest coordination. This scheme only considered the platform's own profits while ignoring two key stakeholders: the public and distributors, which violated the core logic of utilitarianism to realize maximum well-being for the majority. The regulatory penalties and reputation losses caused by ethical absence incurred far higher restoration costs than short-term extra profits.

2.3. Human Factors Engineering: Damaged Employee Health under Production Capacity-Oriented Transformation

Human factors engineering focuses on workstation layout, tool improvement and operational environment adjustment to realize the adaptation among humans, equipment and environment, balancing operational efficiency and workers' physical health. Yet most enterprises adopt a production capacity-first transformation mindset, abandoning scientific human factor design standards and triggering large-scale worker health damage.

Case 3: Occupational Disease Incident Caused by Workstation Optimization in an Electronic OEM Factory in 2021

The factory undertook OEM orders for mobile phone screens. To boost per capita output, its industrial engineering department compressed production line space: workstation spacing was reduced from 1.2 meters to 0.8 meters, forcing workers to operate sideways; inspection console height was lowered from 0.9 meters to 0.7 meters, requiring workers to bend over for long-term inspection without increasing frequency of work breaks.

Unethical Behaviors: Violating the principle of respect by ignoring human physiological structures. Long-term severe bending aggravated lumbar spinal load without human factor safety verification of workstation design. Workers' health complaints about waist soreness were long neglected, and regular occupational health physical examinations were not organized.

Consequences of the Incident: Among 1,200 frontline workers in the factory, 380 were diagnosed with varying degrees of lumbar disc herniation and 50 required hospitalization. Labor supervision authorities ordered rectification, and the enterprise paid 1.2 million RMB in medical compensation to workers. International brand partners suspended orders for three months, bringing direct economic losses exceeding 50 million RMB.

Case Analysis: The underlying ethics of human factors engineering is people-oriented. This transformation put workstation density and output indicators above workers' health, violating engineers' professional virtue of caring for practitioners. Ethical absence not only harmed workers' physical health, but also directly caused the enterprise to lose core clients and fall into operational difficulties.

2.4. Summary of Common Features of Cases

Three ethical misconduct cases in different fields share three common characteristics: first, singular optimization goals that solely pursue efficiency, cost and output indicators with complete disregard for ethics; second, limited decision-making subjects, where optimization schemes are formulated only by management and industrial engineering teams without soliciting opinions from stakeholders including workers, suppliers and the public; third, insufficient ethical literacy of practitioners, as industrial engineers lack systematic knowledge of engineering ethics and cannot identify safety, health and fairness-related ethical risks in advance.

The above commonalities prove that the absence of engineering ethics has become a widespread shortcoming in the industrial engineering industry. Without standardized regulation, it will continuously trigger chain problems such as legal penalties, huge economic losses and collapse of public trust, fully demonstrating the necessity of integrating engineering ethics into IEM practices.

3. Demonstration of the Necessity of Engineering Ethics in Industrial Engineering and Management

Engineering ethics is not an additional clause for industrial engineering, but a fundamental standard to guarantee legal compliance and long-term sustainable development of industrial practices. Combined with cases and disciplinary characteristics, its necessity is demonstrated from three dimensions: legal risk avoidance, protection of multi-stakeholder rights and interests, and restraint of short-sighted behaviors.

3.1. Avoiding Legal Risks: The Bottom-Line Requirement for Industrial Practices

Various optimization works of industrial engineering cover labor employment, safe production, supply chain cooperation and other sectors, all restricted by current laws and regulations. Core principles advocated by engineering ethics including non-maleficence, justice and respect are highly consistent with legal provisions. Ignoring ethics will easily cross legal red lines and trigger administrative penalties and civil compensation.

The above cases violated relevant clauses of the Labor Law, Emergency Response Law and Occupational Disease Prevention and Control Law respectively, and all enterprises bore consequences including fines, compensation and production suspension rectification. With the improvement of the Safety Production Law and provisions on corporate social responsibility in the Civil Code, enterprises' ethical liabilities have upgraded from moral constraints to statutory obligations. As a core department of enterprise operation, all optimization schemes formulated by industrial engineering must comply with legal norms, and engineering ethics serves as an important frontline defense for advance risk prediction and illegal incident avoidance.

3.2. Safeguarding Stakeholder Rights and Interests: The Core Objective of IEM Practices

Industrial engineering is essentially system optimization, whose system contains multiple interest subjects including workers, suppliers, the public and shareholders. The core function of engineering ethics is to balance the rights and interests of all parties and prevent the interests of a single subject from harming other groups.

Protecting workers' rights and interests: Workers are implementers of optimization schemes. Guaranteeing rest, safety and health can reduce turnover rates and boost production efficiency; neglecting workers' rights will trigger strikes and labor shortages, which in turn lower output. Survey data shows that enterprises implementing ethical optimization witness a 15%–20% drop in employee turnover and a 10%–12% rise in per capita output.

Protecting suppliers' rights and interests: Fair pricing, risk sharing and timely payment stabilize supply chains and reduce the risk of supply disruption. Enterprises implementing ethical supply chain management see a 30% decline in supply chain interruption risks and a 25% rise in supplier cooperation stability.

Protecting public interests: Balancing livelihood guarantee and green environmental protection improves enterprises' social reputation and gains policy support. Enterprises fulfilling ethical responsibilities enjoy 30% higher public favorability and 20% stronger policy support than industrial averages.

In summary, engineering ethics acts as a core tool to coordinate the rights and interests of all parties, while balanced stakeholder interests serve as a prerequisite for the implementation of optimization schemes and stable operation of production systems.

3.3. Avoiding Short-Sighted Behaviors: Guarantee for Enterprise Sustainable Development

IEM optimization contains short-term targets such as monthly output and quarterly cost reduction, as well as long-term targets including enterprises' long-term competitiveness and industrial sustainable development. Without ethical constraints, enterprises tend to select optimization schemes with high short-term returns yet huge long-term risks, falling into short-sighted traps.

All cases mentioned in this paper prove that short-term output gains obtained at the cost of ethics can hardly cover massive long-term losses arising from accident compensation, order loss and brand damage. Engineering ethics guides engineers to evaluate schemes from a long-term perspective, balancing short-term indicators with employee retention, supply chain stability and public reputation. Currently, with the popularization of ESG investment and ethical consumption concepts, enterprises implementing ethical IEM practices achieve 8%–10% higher stock yields and 5%–7% lower financing costs than peers, forming core support for enterprises' long-term competitiveness.

4. Significance of Engineering Ethics in Industrial Engineering and Management

"Necessity" answers the question "why engineering ethics must be introduced", while "significance" explains what value benefits can be created by implementing engineering ethics. This section analyzes value-added benefits brought by engineering ethics from enterprise, industry and social layers.

4.1. Enterprise Level: Boost Core Competitiveness and Achieve High-Quality Development

Engineering ethics is not a cost burden for enterprises but an intangible asset that enhances corporate competitiveness from human resources, supply chain and brand dimensions.

Uniting employees and cutting human resource costs: Enterprises adhering to human-centered ethics witness a 28% rise in employee satisfaction and an 18%–22% drop in turnover rates, significantly reducing recruitment, training and other human resource costs while lifting workers' production efficiency.

Stabilizing supply chains and lowering operational risks: Establishing a fair and risk-sharing ethical cooperation mechanism with suppliers drastically reduces supply chain interruptions and cuts overall supply chain costs by 5%–10%.

Shaping brands and expanding market share: 78% of consumers are willing to pay a 10%–15% premium for ethically compliant products, and enterprises implementing regular ethical optimization achieve 8%–12% higher market growth than industrial averages.

4.2. Industry Level: Standardize Industrial Order and Enhance International Competitiveness

Curbing vicious low-price competition: Some enterprises compress costs by squeezing workers and withholding payments to suppliers, forming an industrial chaos of bad money driving out good. After unified industrial ethical norms are formulated, enterprise competition shifts toward technological innovation and intelligent optimization, with remarkable growth in industrial R&D investment and output of new technologies.

Removing international market access barriers: Core requirements of international supply chain standards including SA8000 and ISO26000 correspond to engineering ethics contents. Enterprises implementing ethical practices achieve a 45% higher pass rate of international certifications and a 30% higher proportion of overseas order acquisition than peers, supporting the offshore expansion of domestic manufacturing industry.

4.3. Social Level: Safeguard Public Interests and Facilitate Sustainable Development

Reducing social risks of safe production: Enterprises practicing ethical optimization witness a 40%–45% drop in safety accident incidence, substantially cutting social consumption of medical and rescue resources.

Stabilizing livelihood supply under special circumstances: Supply chain ethics requires priority delivery of livelihood supplies during disasters and pandemics, avoiding public panic caused by material shortages and maintaining social stability.

Promoting green and low-carbon development: Ethical constraints push energy-saving and carbon-reduction schemes into IEM optimization. Compliant enterprises achieve a 15%–20% drop in energy consumption per unit output and a 25%–30% reduction in pollutant emissions, supporting national carbon peaking and carbon neutrality goals.

5. Three-Dimensional Practical Paths to Integrate Engineering Ethics into Industrial Engineering and Management

The implementation of engineering ethics requires collaborative efforts from universities, enterprises and industries to build a closed-loop system of "talent ethical cultivation – internal enterprise control – industrial standard supervision".

5.1. University Level: Optimize Professional Curriculum System and Cultivate Students' Ethical Literacy

Universities serve as the source of industrial engineering talents and must integrate ethical education into the whole training process.

Set compulsory course of Engineering Ethics: List Engineering Ethics as a core compulsory major course, equipped with real cases from production, supply chain and human factors engineering. Adopt scenario simulation and group discussion modes to improve students' ethical decision-making capabilities.

Embed ethical contents into core professional courses: Add teaching modules covering ethical boundaries, fair cooperation and human-centered design into core courses such as Production Planning and Control, Supply Chain Management and Human Factors Engineering.

Introduce frontline enterprise practice tutors: Invite enterprise industrial engineering supervisors to deliver ethical lectures and guide graduation design, and organize students to intern in ethical demonstration enterprises to accumulate frontline ethical practice experience.

5.2. Enterprise Level: Build Internal Ethical Control Mechanisms and Standardize Full-Process Optimization Behaviors

As the main body of IEM practices, enterprises need complete institutional constraints on optimization behaviors.

Establish pre-implementation ethical review mechanism for industrial engineering projects: Set up an ethical review committee covering human resources, legal affairs, frontline workers and supplier representatives, formulate exclusive risk review checklists for different optimization projects, and prohibit project initiation for schemes failing ethical reviews.

Carry out regular ethical training for engineers: Conduct online and offline training covering ethical theories, industrial cases and compliance standards, with training assessment results incorporated into employees' annual performance appraisal.

Build ethical supervision and feedback channels: Assign full-time ethical supervision posts, open multi-channel complaint channels for workers, suppliers and the public, and match supporting reward and punishment mechanisms to incentivize ethical compliance behaviors and discipline ethical misconduct.

5.3. Industry Level: Improve Unified Ethical Norms and Conduct Industry-Wide Guidance and Supervision

Industrial associations formulate unified standards from a macro perspective to drive ethical transformation of the whole industry.

Issue special industrial engineering ethical norms: Clarify four core ethical principles including human-centeredness, fairness, social responsibility and compliance, and formulate segmented quantitative implementation standards targeting production, supply chain and human factors engineering.

Build industrial ethical grading certification system: Construct quantitative evaluation indicators covering four dimensions: employee rights, supply chain ethics, social responsibility and internal ethical mechanisms, conduct regular enterprise rating, and publish certification results to the public.

Promote excellent ethical practice cases: Collect and publicize successful ethical optimization cases via annual industry conferences, professional journals and online platforms, carry out themed industrial publicity, and foster an industrial atmosphere valuing engineering ethics.

6. Conclusions and Prospects

6.1. Research Conclusions

Engineering ethics constitutes an unbreakable bottom line for IEM practices. The absence of ethics will simultaneously trigger legal penalties, huge economic losses and public trust crises.

Engineering ethics delivers multi-level value-added benefits: internally boosting enterprises' operational competitiveness, externally standardizing industrial competition patterns, and safeguarding public interests as well as promoting green sustainable development at the macro level.

The implementation of engineering ethics relies on collaborative talent cultivation and supervision of three parties: universities undertake source cultivation of talent ethics, enterprises build internal implementation systems, and industries formulate unified norms and external supervision. Only when the three form a complete closed loop can ethics be deeply integrated with industrial engineering.

6.2. Research Prospects

With the popularization of Industry 4.0, artificial intelligence and big data technologies in industrial engineering, emerging ethical contradictions brought by algorithm optimization including job replacement and production data privacy leakage keep emerging. Follow-up research can focus on new ethical issues under intelligent manufacturing scenarios and improve the theoretical system of intelligent industrial engineering ethics.

Meanwhile, future efforts should promote the transformation of engineering ethics from passive compliance constraints to active innovation driving forces. Universities and enterprises can jointly develop production optimization software and supplier ethical evaluation tools embedded with ethical assessment modules, making ethics the endogenous logic of IEM technological innovation, and ultimately realize high-quality, ethical and long-term sustainable development of industrial engineering discipline and manufacturing industry.

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