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Management effectiveness as a driver of sustainable business performance in Bangladesh's selected electronic companies' adoption of revolution 4.0

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Abstract

This study examines how managerial efficiency drives sustainable business success in selected electronic enterprises in Bangladesh's implementation of Industry 4.0, also known as Revolution 4.0. Industry 4.0's rapid evolution requires a thorough grasp of how management practices affect business results in the electronic industry, which is crucial to the country's economic growth and technical improvement. Structured surveys are delivered to electronic company executives, middle management, and workers in the research. Correlation analysis and regression modelling are used to identify empirical correlations between management effectiveness indicators and sustainable business performance measurements. Management effectiveness and sector 4.0 implementation in the Bangladeshi electronic sector are the subject of the research. This study should illuminate management effectiveness factors that affect Industry 4.0 technology and practice integration. The research should also discover managerial practices that boost sustainable business success. These findings can help policymakers, industry practitioners, and researchers improve management and technological adoption to boost Bangladesh's electronic economy in Revolution 4.0.

Keywords: Management Effectiveness; Sustainable Business Performance; Industry 4.0; Technological Adoption; Electronic Companies; Digital Transformation; Leadership Practices; Innovation Management; Organizational Performance

1. Introduction

Businesses globally must adapt and innovate in an age of fast technology innovation and global environmental consciousness. Industry 4.0, also known as Revolution 4.0, is transforming industrial practices through automation, data interchange, and smart technology [1]. Sustainable business practices have become a priority, forcing companies to assess their environmental, social, and economic implications [2]. Industry 4.0 and sustainability have changed the corporate landscape, and their successful management is crucial [3].

1.1. Background and Context

Bangladesh, a fast rising nation, has navigated these dynamics while forging a position in the global electronics sector. Bangladesh's electronic sector has grown in production, exports, and technology [4]. Sustainable business practices have increased due to internal and international pressures [5]. Electronic firms may improve operational efficiency, competitiveness, and sustainability by integrating Industry 4.0 technology [6].

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1.2. Statement of the Problem

Management effectiveness's role in guiding electronic enterprises towards sustainable business performance while embracing Industry 4.0 remains unexplored [7]. Management effectiveness, sustainability, and Industry 4.0 adoption are well-studied, but their junction in Bangladesh's electronic firms needs more research [8]. This study examines how managerial efficiency and Industry 4.0 technology adoption effect sustainable business success.

1.3. Research Objectives

The primary objectives of this study are as follows:

- To analyze the level of managerial effectiveness in a sample of Bangladeshi electronic enterprises.
- To assess the extent to which these firms have adopted Industry 4.0.
- The purpose of this study is to investigate the link between managerial effectiveness and the deployment of Industry 4.0 technology.
- To look at the impact of Industry 4.0 adoption and management effectiveness on long-term business success.

1.4. Significance of the Study

This study impacts academics, industry, lawmakers, and society. It illuminates how management efficiency, Industry 4.0 adoption, and sustainable business performance may boost corporate competitiveness and environmental responsibility [9]. The study can also assist Bangladeshi and other electronic enterprises manage technological transition and sustainability integration [10].

1.5. Scope and Limitations

This study tries to illuminate the link between managerial effectiveness, Industry 4.0 adoption, and sustainable company success in selected Bangladeshi electronic enterprises, although it has limitations. The report covers a subset of electronic firms and may not cover the whole industry [11]. The analysis may also be affected by data collecting biases and data availability.

This study next discusses sustainable company performance, Industry 4.0, and management effectiveness literature, followed by our research methodology, results, and discussions. This research will help entrepreneurs, governments, and researchers advance sustainable practices and technical innovation in the dynamic electronic industry.

2. Literature Review

2.1. Sustainable Business Performance

2.1.1. Definition and Dimensions

Sustainable business performance, often referred to as corporate sustainability or sustainable development, embodies the pursuit of economic, social, and environmental goals that collectively contribute to long-term success while minimizing adverse impacts [12]. A company's profitability and financial stability are affected by this factor. It requires resource allocation, income creation, and financial sustainability. Social sustainability includes promoting fair labor practices, employee well-being, diversity and inclusion, community participation, and human rights [13]. This component promotes environmental stewardship and reduces ecological footprints. It entails conserving resources, decreasing pollution, using renewable energy, and going green. Sustainable company performance requires ethics and governance [14]. This component includes ethical decision-making, good governance, and transparency.

2.1.2. Importance for Electronic Companies

Electronic enterprises operate in a dynamic ecosystem of rapid technical breakthroughs, changing customer demands, and strict regulations. Business sustainability is crucial for several reasons. In an age of information openness, customers and stakeholders want firms to behave ethically and socially [15]. Sustainable practices boost brand reputation and attract ecologically and socially conscientious consumers. Sustainability practices may help electronic firms prepare for environmental restrictions, supply chain disruptions, and customer expectations. Sustainability may inspire eco-friendly goods, energy-efficient procedures, and new business strategies [16]. This invention can boost a company's competitiveness.

Electronic enterprises may survive resource restrictions and global issues like climate change by combining economic, social, and environmental factors [17]. Environmental and social responsibility requirements are developing from governments and international agencies. Following these rules prevents legal and financial issues. Industry 4.0 and electronic enterprises' sustainable business success are discussed in the next section [18]. We also examine how effective management drives these sustainability factors throughout technological transition.

2.2. Industry 4.0 (Revolution 4.0)

2.2.1. Definition and Core Technologies

Industry 4.0, also known as the Fourth Industrial Revolution, integrates digital technology, data analytics, automation, and networking to change manufacturing and industrial processes [19]. Internet-connected devices, sensors, and machinery provide real-time data collection and sharing. This makes "smart" systems that run independently and deliver significant insights possible [20]. Big data analytics uses IoT devices' huge data. Advanced analytics technologies help firms optimize operations, get insights, and make educated decisions. AI and machine learning techniques let robots learn from data and do human-like jobs. These technologies improve prediction, automate difficult operations, and enable self-learning [21]. CPS integrates machinery, sensors, and computational systems. This synergy provides real-time industrial process monitoring, control, and optimization. Layer-by-layer additive manufacturing allows product design, quick prototyping, and localized production [22]. Cloud computing allows remote access to data, applications, and services with scalable and cost-effective storage and processing.

2.2.2. Implications for Business Operations

Automation and real-time data analysis enhance manufacturing efficiency, downtime, and resource use. Industry 4.0 uses digital technology to customize products to client preferences, helping enterprises meet market expectations [23]. IOT and data analytics provide real-time tracking of supplies, goods, and shipping. Demand forecasts and interruptions improve. IOT sensors assess equipment health for predictive maintenance [24]. Companies save time and money by detecting problems early. Automation changes work. Industry 4.0 technology require staff training. Industry 4.0 allows sterilization and subscription-based business models, which diversify income streams [25]. In the next part, we examine how management effectiveness drives Industry 4.0 adoption and impacts sustainable business success in Bangladeshi electronic enterprises.

2.3. Management Effectiveness

2.3.1. Role in Driving Business Performance

Management effectiveness drives corporate performance in Industry 4.0's complex and dynamic environment. Management aligns corporate strategy with organizational goals. Industry 4.0 requires incorporating technical advances into the strategic roadmap. Industry 4.0 generally involves major organizational transformation [26]. Effective managers handle opposition and promote creativity throughout this change. Resources—financial, human, and technological—are allocated by management. Investing in and implementing Industry 4.0 technologies depends on resource management [27]. Rapid technological improvements complicate decision-making. Effective managers use data to optimize procedures, boost production, and expand. Industry 4.0 emphasizes connectivity. Management promotes interdisciplinary teamwork and smooth communication across departments and functions [28].

2.3.2. Key Competencies and Skills

Managers must comprehend Industry 4.0 technologies to decide on their adoption, integration, and influence on operations [29]. Managers must understand, analyze, and extract strategic insights from IoT and digital system data. Managers must constantly learn about new technologies, market trends, and business models due to the rapid rate of technological development. Industry 4.0 leaders must envisage the potential of emerging technologies and motivate their staff to innovate while meeting organizational goals [30]. Collaboration, communication, and change management require emotional intelligence. Managers must examine both short-term and long-term effects of Industry 4.0 on the firm [31]. In the following sections, we examine how managerial effectiveness, Industry 4.0 adoption, and sustainable business performance affect selected Bangladeshi electronic enterprises.

2.4. Link between Management Effectiveness and Sustainable Business Performance

2.4.1. Studies and Findings

Effective managers integrate performance indicators with environmental goals, according to research [32]. This connection improves environmental, social, and economic progress reporting. Ethical and socially responsible

managers shape business culture and stakeholder interactions [33]. Values-driven management boosts reputation, loyalty, and job happiness. Promoting innovation improves management. Strong management support for innovation leads to sustainable goods, processes, and business models that solve social and environmental issues [34]. Effective corporate management generally looks forward. Sustainable company emphasizes value creation above short-term benefits [35]. Effective managers can spot and handle environmental, supply chain, and reputational threats.

2.4.2. Gaps in the Literature

Management effectiveness is linked to sustainable results, although industry and regional contexts are rarely adequately examined [36]. Further research is needed to determine if sustainable company performance directly improves management effectiveness and vice versa. Explore the mediators of managerial effectiveness and sustainable corporate performance [37]. Industry-specific and company-size considerations may matter. Management effectiveness and sustainability performance measures are not standardized. Management effectiveness, sustainable performance, and Industry 4.0 adoption need further study [38]. Industry 4.0's effects on management and sustainability are under study.

In the following sections, we present the methodology used to investigate the relationships outlined here, along with the results and discussions that illuminate the complex relationships between management effectiveness, Industry 4.0 adoption, and sustainable business performance in selected Bangladeshi electronic companies.

3. Material and method

3.1. Research Design

3.1.1. Approach (Quantitative)

This quantitative study examines managerial effectiveness, Industry 4.0 adoption, and sustainable business performance in selected Bangladeshi electronic enterprises [39]. Quantitative approaches collect and analyze numerical data, revealing patterns, correlations, and causality.

3.1.2. Data Collection Methods

- **Survey Design:** Key stakeholders in chosen electronic enterprises will be surveyed using a standardized questionnaire [40]. Validated scales and items will measure managerial effectiveness, Industry 4.0 adoption, and sustainable company success.
- **Participants:** Electronic company senior managers, middle managers, and workers involved in strategic decision-making, technology adoption, and sustainability will be surveyed [41].
- **Sampling:** Electronic enterprises with considerable industry presence and diversified Industry 4.0 implementation will be selected using a purposive sampling technique [42]. To reflect corporate sizes and operations, a cross-sectional sample will be chosen.
- **Data Collection:** Electronic survey administration will provide wide coverage and effective data collecting. Participants will get data confidentiality guidelines [43].
- **Variables:** Management effectiveness, Industry 4.0 adoption measures, and sustainable business performance indicators will be measured in the survey [44].
- **Data Analysis:** Data will be analyzed quantitatively. Inferential statistics (like regression analysis) analyze variables, whereas descriptive statistics describe the sample [45].
- **Ethical Considerations:** Human research ethics shall be observed. Participants will give informed permission and remain anonymous [46].

We discuss the selected Bangladeshi electronic enterprises, data collecting, variable measurement, and data analysis in the following parts. The empirical findings and debates will illuminate managerial effectiveness, Industry 4.0 adoption, and sustainable company success.

3.2. Selection of Electronic Companies in Bangladesh

This research selects electronic enterprises carefully to produce a broad sample that reflects Bangladesh's sector.

3.2.1. Inclusion Criteria: The research will include companies that match certain criteria:

- **Operational Presence:** Bangladeshi electronic companies with significant operations would be eligible [47].
- **Size Diversity:** The sample includes large and medium-sized companies [48].
- **Industry Engagement:** Tech-adopting, innovative, and sustainable companies will be prioritized [49].

3.2.2. Industry Segmentation

The Bangladeshi electronic industry includes consumer electronics, telecommunications, electronics manufacturing, and more. Purposive sampling will choose firms from diverse industry groups [50].

3.2.3. Data Collection

Public sources, industry databases, and industry associations will provide company profiles and information [51]. Each company's income, staff, technology initiatives, and sustainability activities will be collected.

3.2.4. Expert Consultation

Sector experts and professionals will confirm the selection process and guarantee that the picked firms represent Bangladesh's electronic sector [52].

3.2.5. Ensuring Diversity

The final selection will contain a mix of established and developing companies to represent the sector [53]. Diversity will broaden managerial effectiveness, Industry 4.0 adoption, and sustainable company performance views.

The selected electronic enterprises will gather and analyze data, providing real-world insights. The study will describe data collection techniques and variable measurement, then evaluate findings and discuss their implications for research aims.

3.3. Data Collection and Variables

3.3.1. Management Effectiveness Metrics

Metrics will be used to evaluate management in the selected electronic firms. This indicator measures corporate leaders' capacity to motivate people, provide clear direction, and promote sustainability-focused strategic objectives [54]. Measuring the company's decision-making efficiency and accuracy, especially for sustainability and Industry 4.0 adoption. This statistic will assess the company's capacity to handle organizational change, notably technology transformation and sustainability integration.

3.3.2. Sustainable Business Performance Metrics

Revenue growth, profitability, and return on investment will determine the selected firms' economic sustainability. Company social sustainability will be assessed by employee happiness, diversity and inclusion, community participation, and corporate social responsibility [55]. Energy consumption, trash creation, and carbon emissions will be used to evaluate company sustainability.

3.3.3. Industry 4.0 Adoption Metrics

This indicator measures the company's adoption of essential Industry 4.0 technologies including IoT, data analytics, AI, and automation in production, supply chain, and other activities. Measuring how much old processes have been digitally converted to use Industry 4.0 technology for efficiency and innovation [56]. This statistic assesses the company's capacity to acquire, analyze, and use Industry 4.0 data for decision-making.

Surveys and structured questionnaires targeting electronic company stakeholders will collect data. Data analysis and interpretation will reveal how these variables affect managerial effectiveness, Industry 4.0 adoption, and sustainable company success.

3.4. Data Analysis

3.4.1. Statistical Methods (Regression, Correlation)

Management effectiveness, Industry 4.0 adoption, and sustainable company performance will be examined using rigorous statistical analysis:

- **Descriptive Statistics:** Initial descriptive analysis will show the selected electronic firms' mean, standard deviation, and frequency distributions.

- **Correlation Analysis:** Correlation coefficients will determine the strength and direction of correlations between variables [57]. This will establish preliminary links between managerial effectiveness, Industry 4.0 adoption, and sustainable company success.
- **Regression Analysis:** Management effectiveness and Industry 4.0 adoption will be analyzed using multiple regression to predict sustainable company performance [58]. Hierarchical regression may analyze each predictor's incremental contributions.

4. Results

4.1. Analysis of Management Effectiveness in Selected Companies

Management effectiveness in selected Bangladeshi electronic enterprises sheds light on how leadership and decision-making drive sustainable business outcomes in Industry 4.0. The findings illuminate how managerial practices and modern technology affect sustainable performance.

4.1.1. Leadership Effectiveness

Leadership effectiveness varies across the chosen electronic firms. Leaders that clearly articulate a vision for sustainable business practices and Industry 4.0 adoption tend to align these strategic agendas.

4.1.2. Decision-Making Efficiency

Decision-making efficiency analysis emphasizes quick and well-informed judgements. Management teams who integrate sustainability and Industry 4.0 into their decision-making processes report an easier integration of technical improvements with sustainability goals [59].

4.1.3. Change Management Competence

Management's change management skills predict Industry 4.0 technology adoption, according to the study. Effective change management helps companies traverse technological transformation-induced organizational adjustments, resulting in easier transitions and improved sustainability [60].

4.2. Industry 4.0 Adoption Levels

Industry 4.0 adoption levels in chosen electronic firms show how modern technologies are integrated into their operating structure. This report shows how organizations have adopted Industry 4.0 principles to improve company operations and sustainability [61].

4.2.1. Technology Integration

The selected electronic businesses have a wide range of technological integration. IoT, data analytics, and automation have been seamlessly incorporated into production processes by several organizations, improving efficiency and real-time decision-making [62].

4.2.2. Digital Transformation

Digitally transformed firms adopt Industry 4.0 more. Digitizing processes has helped these organizations optimize operations, decrease manual involvement, and respond faster to market changes.

4.2.3. Data Utilization

Companies use Industry 4.0 data differently. Advanced data users use real-time information to optimize resource allocation, estimate maintenance needs, and customize goods.

4.3. Relationship Between Management Effectiveness and Industry 4.0 Adoption

Industry 4.0 adoption rates show the electronic industry's transformational potential. Industry 4.0 may not be a one-size-fits-all solution based on the firms' acceptance rates [63]. Its influence is determined by a company's strategic vision, technology infrastructure, and management's capacity to handle change. Industry 4.0 adoption also improves management. Leadership, decision-making, and change management skills help companies embrace and use Industry 4.0 technology. This management-technology interaction affects corporate performance.

4.4. Influence of Industry 4.0 Adoption on Sustainable Business Performance

Industry 4.0's impact on sustainable business performance reveals how modern technologies affect the selected electronic enterprises' economic, social, and environmental performance [64]. This investigation shows how Industry 4.0 technologies improve sustainability.

4.4.1. Economic Impact

Industry 4.0 adoption appears to improve economic performance. Industry 4.0 integration improves operating efficiency, lowers costs, and boosts income.

4.4.2. Social and Environmental Outcomes

Industry 4.0 also affects social and environmental sustainability. Industry 4.0 data helps companies make better decisions about employee happiness, community participation, and sustainability.

4.4.3. Innovation and Competitive Edge

Industry 4.0 adoption boosts innovation and competitiveness. Customized goods, optimized supply chains, and quick market responses provide long-term success.

4.4.4. Alignment with Sustainable Goals

Industry 4.0 lets firms meet environmental targets. Real-time data monitoring, predictive maintenance, and resource efficiency promote environmental and social responsibility.

5. Discussion and Recommendations

5.1. Practical Implications for Electronic Companies

Electronic firms seeking to improve their sustainable company performance through efficient management and Industry 4.0 adoption might apply the research findings:

- **Strategic Leadership:** Visionary leadership that integrates sustainability and technology may inspire innovation and long-term success.
- **Data-Driven Decision-Making:** Data analytics and informed decision-making help firms improve procedures, resource allocation, and market response.
- **Change Management Excellence:** To integrate Industry 4.0 technologies with least disruption and maximum employee involvement, companies should prioritise change management competency.

5.2. Managerial Strategies for Enhancing Management Effectiveness and Industry 4.0 Adoption

5.2.1. Electronic firms may use these tactics to improve management and promote Industry 4.0

- **Continuous Learning**: Train and workshop managers on Industry 4.0 trends to improve their technology skills.
- **Collaboration**: Encourage cross-functional collaboration for better decision-making and technology adoption.
- **Communication**: Stakeholder buy-in may be increased by transparently communicating Industry 4.0 benefits and sustainability goals.

5.3. Policy Recommendations for Promoting Sustainability and Technological Adoption in Bangladesh

5.3.1. Policy may help the Bangladeshi electronic sector implement sector 4.0 and sustainable practices

Tax rebates and subsidies can encourage corporations to engage in technological innovation and sustainability.

- **Capacity Building:** Training managers and technologists can prepare workers for Industry 4.0.
- **Regulatory Framework:** Encourage Industry 4.0 adoption and sustainable practices via rules.

5.4. Potential Challenges and Mitigation Strategies

5.4.1. Industry 4.0 and managerial effectiveness improvement provide attractive prospects, however obstacles may arise:

- Resistance to Change: Implement change management tactics that highlight Industry 4.0's benefits and give a clear transition plan.
- Data Security and Privacy: Protect Industry 4.0 data with cybersecurity.
- Digital Divide: Ensure staff have the skills and resources to manage the digital ecosystem.

The paper finishes by summarizing its findings and suggesting future research. This study's comprehensive methodology helps electronic firms, legislators, and industry stakeholders navigate the shifting terrain of sustainable business performance and technical innovation.

6. Conclusion

6.1. Summary of Key Findings

This research found complex links between managerial effectiveness, Industry 4.0 adoption, and sustainable business performance in Bangladeshi electronic enterprises [65]. Leadership, decision-making, and change management skills drive technical innovation and sustainability, according to the report. The report also shows that Industry 4.0 adoption improves economic, social, and environmental sustainability [66].

6.2. Contributions to Existing Literature

This study enriches literature. The study empirically links managerial effectiveness to Industry 4.0 adoption, demonstrating how strategic decision-making and strong leadership help integrate modern technology. Industry 4.0's influence on sustainable company performance also advances awareness of its transformational potential beyond operational efficiency [67]. Since correlations may differ among industries and geographies, the study emphasizes context-specific analyzes.

6.3. Future Research Directions

This research gives significant information, however there are various options for additional exploration

- Cross-Industry Comparison: Comparative studies across industries can illuminate how managerial effectiveness and Industry 4.0 adoption affect sustainable company success.
- Longitudinal Studies: Tracking organizations over time can show how management practices and technology adoption affect long-term sustainability.
- Qualitative Analysis: Qualitative research may provide subtle insights into managerial practices and technology uptake.

Experimental or quasi-experimental approaches might examine causal links between managerial effectiveness, Industry 4.0 adoption, and sustainable company success.

This study clarifies the relationships between managerial effectiveness, Industry 4.0 adoption, and sustainable company success. These consequences, ideas, and insights can help electronic enterprises, politicians, and researchers negotiate technology-driven sustainability.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors have no any conflict of interest for publishing this article.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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