

Digital Quality Management and Climate-Oriented Performance in Moroccan Industrial Firms

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Abstract. This paper examines how digital quality management can support climate-oriented performance in Moroccan industrial firms. Total quality management and sustainability have been widely discussed, but the operational mechanism through which digitalized quality practices produce climate-related improvement is still poorly specified, particularly in emerging industrial economies. Drawing on the resource-based view, dynamic capabilities theory, and the natural resource-based view, the paper develops a testable model in which digital quality management improves climate-oriented performance through data-driven process control. The model also proposes environmental strategic commitment as a boundary condition that strengthens the translation of process data into climate-oriented improvement. A quantitative research design is proposed, based on a structured survey of Moroccan industrial firms targeting managers and professionals in quality, production, operations, logistics, sustainability, digital transformation, and continuous improvement. The analysis plan combines reliability analysis, exploratory factor analysis, correlation analysis, multiple regression, mediation testing, and moderation testing in IBM SPSS Statistics. The contribution is to connect Quality 4.0, evidence-based process control, and climate-oriented performance in a model that is grounded in theory and can be tested empirically. The paper offers practical guidance for firms seeking to move from formal quality systems toward measurable environmental and operational improvement.

Keywords. Digital quality management; Quality 4.0; data-driven process control; climate-oriented performance; Moroccan industrial firms; environmental strategic commitment; sustainable operations; SPSS

I. INTRODUCTION

Industrial firms are under growing pressure to become more competitive while reducing their environmental footprint. This double requirement is visible in global value chains, where customers, regulators, and partners increasingly expect firms to prove responsible use of energy, materials, and data as well as product quality. For Moroccan industrial firms the challenge is especially important, because competitiveness depends on quality certification [1], export readiness, operational discipline, and the capacity to respond to climate-related expectations. In this context, quality management can no longer be reduced to inspection, documentation, or formal compliance. It has to become more digital, more analytical, and more closely connected to environmental improvement.

The rise of Quality 4.0 has opened a new line of research on the modernization of quality management. Recent reviews describe Quality 4.0 as the alignment of quality practices with Industry 4.0 technologies, including data analytics, connectivity, automation, digital platforms, and smart monitoring [2]-[4]. Quality then becomes a data infrastructure through which firms can observe processes, detect deviations, and learn faster, in addition to a set of procedures. Technology alone is not sufficient, though. Firms may collect data without using them, install dashboards without changing decisions, or digitize documents without improving performance. The real issue is how digital quality practices are translated into better operational control.

This article addresses that missing link by introducing data-driven process control as a mediating mechanism. Data-driven process control is the use of operational and quality data to monitor activities, detect process variation, identify root causes, and support corrective or preventive actions. It is the practical bridge between digital quality management and climate-oriented performance. If quality data are used only for reporting, their environmental value remains limited. If they are used to reduce defects, avoid rework, control waste, optimize resources, and monitor energy-related deviations, they can contribute to climate-oriented improvement.

In this study, climate-oriented performance means the firm's ability to improve outcomes related to resource efficiency, waste reduction, energy discipline, emissions awareness, and environmental monitoring. The concept is intentionally operational. It refers to measurable improvements that process data can support rather than to broad sustainability declarations. The choice matters because many firms claim environmental commitment, while the real challenge is to embed climate objectives in daily operational routines.

The research question is therefore how digital quality management contributes to climate-oriented performance in Moroccan industrial firms, and what role data-driven process control plays in this relationship. The paper develops a model in which digital quality management influences climate-oriented performance directly, and indirectly through data-driven process control. It also proposes that

environmental strategic commitment strengthens the relationship between data-driven process control and climate-oriented performance.

II. THEORETICAL BACKGROUND AND LITERATURE REVIEW

The resource-based view holds that firms achieve superior performance when they possess valuable capabilities that are difficult to imitate [5]. Digital quality management can be considered such a capability, because it allows an organization to collect, process, and use information for continuous improvement.

Dynamic capabilities theory emphasizes the ability of firms to sense opportunities, seize them, and reconfigure resources [6]. Data-driven process control reflects this logic, since it lets managers identify deviations, learn from evidence, and adapt operations quickly.

The natural resource-based view extends the theory of competitive advantage to environmental capabilities [7]. Pollution prevention, waste reduction, and resource efficiency can become strategic assets when they are built into organizational routines.

In this study, digital quality management (DQM) covers digital data collection, dashboards, traceability systems, digital corrective actions, and evidence-based decision making. Data-driven process control (DDPC) refers to monitoring indicators, detecting deviations, conducting root-cause analysis, and implementing corrective actions. Climate-oriented performance (COP) reflects reductions in waste, material losses, and unnecessary energy consumption. Environmental strategic commitment (ESC) represents leadership support, environmental priorities, and the allocation of resources to sustainability initiatives.

Previous studies have reported positive relationships between digital transformation, environmental, social, and governance (ESG) performance, and sustainability outcomes [8]-[12]. Little research, however, explains how the

digitalization of quality management contributes to climate-oriented improvement at the process level. This study addresses that gap.

III. CONCEPTUAL MODEL AND HYPOTHESES

The conceptual model (Fig. 1) proposes five hypotheses:

- *H1*: Digital quality management positively affects data-driven process control.
- *H2*: Data-driven process control positively affects climate-oriented performance.
- *H3*: Digital quality management positively affects climate-oriented performance.
- *H4*: Data-driven process control mediates the relationship between digital quality management and climate-oriented performance.
- *H5*: Environmental strategic commitment positively moderates the relationship between data-driven process control and climate-oriented performance.

The model assumes that digital technologies create value when data are transformed into operational improvements. Environmental commitment strengthens this process by directing managerial attention toward climate-related objectives.

IV. METHODOLOGY

A quantitative research design is adopted. Data will be collected through a structured questionnaire distributed to Moroccan industrial firms in sectors such as automotive, aeronautics, agri-food, textiles, chemicals, and construction materials.

Respondents will include quality managers, production managers, operations managers, engineers, sustainability specialists, and general managers. A purposive sampling strategy will be used to reach individuals with relevant knowledge. The study aims to collect between 150 and 200 valid responses.

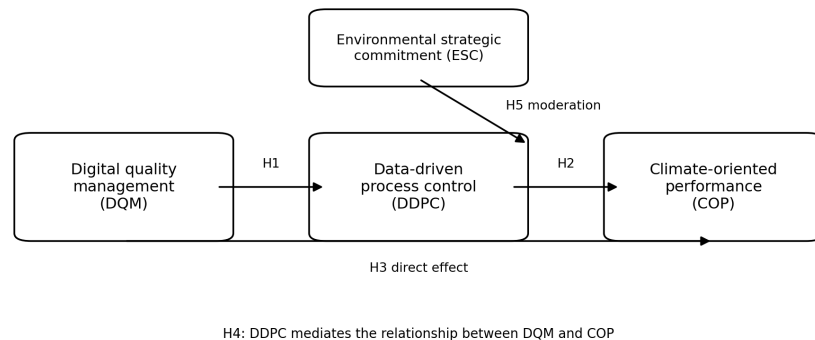


Fig. 1. Conceptual model: digital quality management (DQM), data-driven process control (DDPC), climate-oriented performance (COP), and environmental strategic commitment (ESC), with hypotheses H1 to H5.

The questionnaire will have five sections, covering firm characteristics, digital quality management, data-driven process control, climate-oriented performance, and environmental strategic commitment. All items will be measured on five-point Likert scales.

Example items for digital quality management include the use of digital dashboards, electronic traceability systems, and digital corrective action processes. Data-driven process control items focus on monitoring, root-cause

analysis, and evidence-based decisions. Climate-oriented performance items assess waste reduction, resource efficiency, and environmental monitoring. Environmental strategic commitment items evaluate leadership support and environmental priorities.

V. DATA ANALYSIS PLAN

IBM SPSS Statistics will be used for the analysis. The first stage will involve data cleaning and screening, and

descriptive statistics will summarize the characteristics of the sample and the main variables.

Reliability will be assessed with Cronbach's alpha, and exploratory factor analysis will evaluate construct validity. Correlation analysis will provide preliminary evidence on the relationships among the variables.

Multiple regression analysis will be used to test the direct effects. Mediation analysis with bootstrapping will evaluate the indirect role of data-driven process control. Moderation analysis will assess whether environmental strategic commitment strengthens the relationship between process control and climate-oriented performance. Control variables will include firm size, sector, certification status, digital maturity, and respondent experience.

VI. EXPECTED CONTRIBUTIONS

The study contributes to theory by integrating Quality 4.0, process control, and climate-oriented performance in a single framework. It argues that environmental benefits come from the use of quality-related data and not from digital technologies alone.

For managers, the study suggests that organizations should link their digital quality systems to sustainability objectives. Managers can use quality information to identify inefficiencies, reduce waste, and improve environmental performance. The study also adds to the limited literature on emerging industrial economies, particularly Morocco.

VII. LIMITATIONS AND CONCLUSION

The proposed research relies on survey data and a cross-sectional design, which may limit causal interpretation. Future studies could use longitudinal designs, objective environmental indicators, and comparative samples from other countries.

The article proposes that digital quality management can improve climate-oriented performance when firms turn digital information into effective process control practices. It also proposes that environmental strategic commitment strengthens this relationship. In this model, leadership support is an important condition for the success of sustainability initiatives.

AUTHOR CONTRIBUTIONS

All authors contributed to the conception and preparation of this work and approved the final version of the manuscript.

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DECLARATION OF GENERATIVE AI USE

The authors declare that no generative artificial intelligence tools were used in the preparation of this manuscript. The authors take full responsibility for the content of the publication.

DATA AVAILABILITY

No new data were created or analyzed in this study.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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