

Managerial Readiness for Artificial Intelligence in Textile Wastewater Management in Bangladesh

A Conceptual Framework

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Abstract

Artificial intelligence offers potential applications in wastewater monitoring, prediction, and operational decision support. However, selecting a model does not establish that factory managers and treatment operators can use it effectively. This conceptual article examines managerial readiness for artificial intelligence in Bangladesh's textile wastewater management. It brings together selected literature on organizational readiness, artificial intelligence capabilities, and wastewater applications, alongside Bangladesh-specific research and institutional reports. The article proposes six readiness domains: strategic commitment, managerial and operator knowledge, data stewardship, operational integration, investment and partnership capacity, and accountable decision making. It further distinguishes exploratory interest, supervised experimentation, routine decision support, and controlled operational integration as different adoption states. Four propositions explain how readiness may influence movement between these states and the translation of adoption into environmental performance. A proposed qualitative multiple-case design specifies evidence needed to examine these propositions, including decision histories, operational records, interviews across organizational levels, and observations of treatment routines. The framework is an analytical proposal rather than a validated measurement scale or report of completed fieldwork. Its contribution is to connect organizational preparation with the specific decisions, responsibilities, and verification practices required for textile wastewater management. Empirical research is needed to assess its relevance across factories with different resources and treatment arrangements.

Keywords: artificial intelligence, managerial readiness, textile wastewater, Bangladesh, organizational adoption, conceptual framework

I. INTRODUCTION

Wastewater management in textile manufacturing involves decisions about treatment reliability, resource consumption, maintenance, and environmental performance. In Bangladesh, institutional initiatives have supported improvements in industrial resource management. For example, the International Finance Corporation announced a PaCT monitoring portal in 2020 to support factories' water and energy decisions [1]. This is evidence of an initiative for digital resource monitoring; it does not demonstrate adoption of artificial intelligence in effluent treatment plants.

Bangladesh-specific research also provides a basis for examining differences between factories. A 2025 study collected water and electricity information and effluent measurements from 14 textile factories [2]. Such operational measurements establish a relevant management setting, but they do not reveal whether managers understand, trust, or regularly use artificial intelligence. Explaining those practices requires inquiry into organizational decisions as well as technical infrastructure.

Reviews identify applications of artificial intelligence in wastewater prediction, monitoring, and process optimization, alongside difficulties involving data, interpretability, reproducibility, and transfer to practice [3], [4]. A manager considering these tools must decide which problem warrants investment, what evidence is sufficient, who responds to recommendations, and when reliance should be restricted. These decisions make managerial readiness a distinct subject of investigation.

This article asks: How can managerial readiness be conceptualized for artificial intelligence adoption in Bangladesh's textile wastewater management? It develops a context-specific framework and propositions to guide qualitative research. The proposed contribution is a connection between readiness domains and observable decision responsibilities at successive adoption states. The article does not estimate adoption prevalence or report interviews, experiments, or measured environmental improvements.

II. CONCEPTUAL DEVELOPMENT APPROACH

The article uses a focused conceptual synthesis of eight selected sources rather than a systematic review. Targeted web searches conducted on 10 October 2026 combined terms concerning organizational artificial intelligence readiness, artificial intelligence capability, wastewater treatment, and Bangladesh textile resource management. Foundational organizational sources were selected for construct definition, technical reviews for implementation issues, and Bangladesh-specific sources for contextual grounding. Publisher pages, accessible article content, and institutional publications informed the synthesis. The search was not an exhaustive database search and does not support claims about all relevant studies.

The reasoning proceeds in three steps. First, organizational readiness and capability concepts are distinguished from technology availability. Second, the requirements of wastewater decision making are used to specify what managers would need to organize before and during

deployment. Third, these requirements are expressed as domains, provisional relationships, and observable evidence for future cases. Statements supported by existing publications are cited; the domain configuration, adoption-state distinctions, and propositions are the conceptual proposals of this article.

The eight-source selection offers a starting point for theory development. It is too limited to establish that the proposed framework is the first of its kind, to rank determinants by importance, or to evaluate the balance of all empirical evidence. Claims are therefore bounded to the selected literature and the explanatory questions it motivates.

III. CONCEPTUAL FOUNDATIONS

A. Readiness and Capability

Jöhnk, Weißert, and Wyrski organize artificial intelligence readiness around strategic alignment, resources, knowledge, culture, and data [5]. Weiner conceptualizes organizational readiness for change through shared commitment and collective confidence in the ability to implement change [6]. The latter theory originated in healthcare implementation, so its relevance to textile wastewater management requires examination rather than direct assumption. Together, these sources motivate attention to both willingness and the means to act.

Mikalef and Gupta conceptualize artificial intelligence capability as an organizational combination of resources and examine its relationship with creativity and performance [7]. This helps distinguish access to software from the capacity to organize its use. In this article, managerial readiness refers to the preparation of decision makers to authorize, resource, coordinate, evaluate, and govern an identified artificial intelligence application. Organizational readiness is broader and includes conditions that an individual manager cannot establish alone.

Managerial readiness should consequently be assessed through evidence of actions and arrangements, alongside expressed attitudes. Enthusiasm for innovation may coexist with an unclear budget, an absent response procedure, or inaccessible treatment records. Conversely, a manager who postpones deployment after identifying unreliable inputs may demonstrate informed readiness. Readiness is thus proposed as preparation for an appropriate decision, including a reasoned decision to defer adoption.

B. Wastewater Management as a Decision Setting

Wang and colleagues review artificial intelligence applications across water-quality monitoring, laboratory research, and process design [3]. Alvi and colleagues examine deep learning in wastewater treatment and highlight the importance of suitable data and interpretable deployment [4]. These technical opportunities do not establish that a model validated elsewhere will perform reliably under a particular factory's operating conditions. Local evidence remains necessary.

The conceptual focus here is the factory's management of wastewater generated by wet processing, including arrangements with an on-site or shared treatment provider.

Candidate applications include estimating an unmeasured quality variable, identifying an abnormal operating pattern, or advising an operator on a process adjustment. These are examples for research and appraisal, not recommendations that every factory implement each application. Their feasibility depends on the treatment process and information available.

For the framework, artificial intelligence denotes an application using a learned model for prediction, classification, or decision support. A sensor, spreadsheet, monitoring dashboard, or fixed-threshold alarm is not sufficient evidence of this type of adoption. Case researchers should verify the mechanism of a claimed system before assigning an adoption state. This operational boundary prevents general digitization from being recorded as artificial intelligence use.

IV. PROPOSED READINESS FRAMEWORK

Six domains are proposed for assessing managerial preparation. They adapt organizational concepts to wastewater decisions without replacing the original frameworks [5]-[7]. The domains are intended as sensitizing concepts for qualitative inquiry. They do not form a validated scoring instrument, and no weights or readiness threshold are assumed. A factory may be well prepared for a supervised forecasting pilot while remaining unprepared for automated process adjustment.

A. Strategic Commitment

Strategic commitment concerns whether management can specify the wastewater problem, explain why a learned model is appropriate, and identify an accountable sponsor. A proposed application should have a decision purpose, such as providing earlier warning of a treatment disturbance, rather than merely demonstrating modern technology. Observable evidence would include an approved objective, a baseline for comparison, responsibilities, and review conditions. Environmental objectives should be stated independently of publicity or equipment acquisition.

B. Managerial and Operator Knowledge

Knowledge readiness concerns whether managers and operators can understand the intended use, limitations, and uncertainty of a model sufficiently to act. Managers need not develop algorithms, but they should be able to question vendor claims and recognize when additional expertise is required. Operators need practice interpreting outputs and resolving conflicts with treatment observations. Relevant evidence would include training content, observed explanations of model limitations, and examples of how staff handle an unreliable recommendation.

C. Data Stewardship

Data stewardship concerns responsibility for collection, calibration, traceability, storage, and access. A large quantity of records can be unsuitable if timestamps, units, sampling locations, or production conditions cannot be reconciled. A manager should know who checks the measurements and who authorizes their use. Evidence would include instrument

maintenance records, a sampling procedure, identifiable data owners, and documented handling of missing or disputed values. These proposed indicators connect management actions to the data difficulties identified in wastewater reviews [3], [4].

D. Operational Integration

Operational integration concerns the connection between a model output and an authorized action. For an early-warning application, this includes who receives the alert, what check follows, and who may change operating conditions. Records should distinguish model advice from the final decision and the subsequent process response. A useful interview probe is whether a participant can describe a recent decision from input to outcome. General statements that a dashboard is useful provide weaker evidence than a traceable decision episode.

E. Investment and Partnership Capacity

Investment capacity concerns resources throughout the application lifecycle, including data preparation, instruments, integration, training, validation, and maintenance. Partnership capacity concerns the ability to work with vendors, universities, laboratories, and treatment providers while retaining access to essential information. IFC's 2023 textile sustainability report describes broader opportunities for resource-efficiency partnerships [8]; it is not evidence of the artificial intelligence capacities proposed here. Cases should examine actual agreements, continuity of support, and what happens when a supplier relationship changes.

F. Accountable Decision Making

Accountability concerns who can approve, challenge, override, and suspend model-supported decisions. Preparation includes defining operating boundaries, retaining an alternative procedure, and verifying performance with evidence independent of the model's own output. Predictions should not be treated as direct proof of discharge quality. In future cases, researchers should examine escalation procedures and decision records, including occasions when staff rejected a recommendation. This domain is proposed to address the consequences of decisions affecting treatment reliability and environmental performance.

V. ADOPTION STATES AND PROPOSITIONS

Four adoption states are distinguished. Exploratory interest consists of discussion and appraisal without verified operational use. Supervised experimentation consists of testing a specified application with human oversight. Routine decision support exists when staff regularly use outputs within an established workflow. Controlled operational integration exists when a model participates in operating decisions under defined authorization, monitoring, and override arrangements. These states are analytical distinctions, not an inevitable sequence. A factory may stop after experimentation or choose routine advice without automating control.

P1: Strategic commitment combined with lifecycle resources is more likely to support a transition from

exploratory interest to sustained experimentation than either condition alone. The proposed mechanism is that sponsorship authorizes work while resources enable it to continue. A contrasting case would have both conditions yet fail to launch because access, process fit, or another constraint dominates.

P2: Data stewardship and operational integration jointly influence whether experimentation becomes routine decision support. A technically credible prediction has limited operational value if nobody is authorized to respond. Equally, a response procedure cannot compensate for unreliable inputs. Cross-case inquiry should examine whether these conditions occur together and whether rival explanations, such as vendor support or process stability, better account for continuation.

P3: Managerial and operator knowledge combined with accountable decision making supports calibrated reliance on model outputs. Calibrated reliance means using advice within its established scope and challenging it when conditions change. Evidence would include documented checks, justified overrides, and shared understanding of uncertainty. Mere acceptance of every output would not establish this relationship.

P4: Continued adoption does not by itself establish improved environmental performance; the relationship depends on verified process outcomes. A system can be frequently used without improving effluent quality or resource efficiency. Future research should therefore separate evidence of adoption from independent measurements of performance and examine production changes, maintenance, or treatment upgrades as alternative explanations.

These propositions are deliberately conditional. They can guide comparison of configurations rather than encourage a single additive readiness score. A financially constrained factory with credible data routines and operator expertise may sustain a narrow advisory application. A better funded factory may fail to use a more complex application if responsibility is unclear. These are hypothetical contrasts for investigation, not descriptions of observed factories.

VI. PROPOSED QUALITATIVE MULTIPLE CASE INQUIRY

A. Case Boundaries and Selection

A future study could define each case as a factory's wastewater decision system over a specified period. Where treatment is shared or contracted, the boundary should include the relevant external provider and clarify which decisions the factory controls. Purposive selection should seek variation in management arrangements, treatment technology, resource availability, and verified adoption state. Factories that considered and rejected an application would help investigate non-adoption. Case numbers should follow access, comparison needs, and evidence depth rather than a predetermined claim of saturation.

B. Evidence and Ethical Preparation

Interviews could involve senior managers, environmental or compliance staff, treatment operators, and information-technology personnel. Where relevant, external providers could explain responsibilities that factory respondents cannot

describe. Topics should cover a specific adoption decision, reasons for investment or deferral, data practices, response procedures, model limitations, and evaluation. Operational documents and observations would provide evidence against which interview accounts can be compared.

Before recruitment, the researcher should obtain the applicable university ethics approval and organizational permissions. Participation should be voluntary, with arrangements addressing recording, quotation, confidentiality, and withdrawal. Factory identifiers and commercially sensitive records require controlled handling. Researchers should explain the limits of confidentiality applicable to their approved protocol rather than promise absolute protection. These are proposed procedures; no approval or participant recruitment is reported in this article.

C. Analysis and Rival Explanations

Within each case, analysis could reconstruct the decision timeline and compare stated intentions with documented actions. Initial coding would use the six domains while permitting additional explanations to emerge. Case summaries should retain disagreement between organizational roles; a manager's confidence and an operator's uncertainty may coexist. The analysis should record why a passage was interpreted as evidence of readiness, adoption, or performance, keeping these concepts separate.

Cross-case comparison could examine the configurations proposed in P1-P4 and actively seek contradictory cases. Rivals include improvements caused by new treatment equipment, more stable production, conventional automation, stronger maintenance, or external expertise. A traceable record of analytical decisions and discussion with supervisors would strengthen interpretive transparency. Qualitative comparisons may refine explanatory mechanisms, but they would not establish population-level prevalence or isolate causal effects through statistical control.

VII. DISCUSSION AND LIMITATIONS

The framework shifts the unit of appraisal from possession of an artificial intelligence tool to preparation for a particular wastewater decision. Its proposed contribution is the pairing of readiness domains with operational evidence and adoption states. This makes it possible to ask why the same technology supports regular use in one setting but remains an unused pilot in another. The relevance of these distinctions to Bangladesh is a research question, not a demonstrated national pattern.

For managers, the framework suggests beginning with a bounded problem and recording the current decision process before procuring a model. A readiness discussion could then identify the unresolved condition that matters most for that application, such as reliable input measurement or ownership of an alert response. This is a provisional appraisal approach rather than a proven implementation prescription. Any claimed benefit should be compared against the existing process and independently checked.

The article has four principal limitations. It synthesizes a small, purposively selected literature base; transfers some

organizational concepts across sectors; offers unvalidated domain boundaries; and contains no primary evidence from textile managers. External pressures, organizational culture, factory size, and treatment-provider arrangements may require additional constructs. Future work should expand the literature base, refine indicators through expert and operator feedback, and examine whether the proposed relationships survive comparison with contrary evidence.

VIII. CONCLUSION

Managerial readiness for artificial intelligence in textile wastewater management is proposed as preparation to authorize, resource, coordinate, evaluate, and govern a defined application. Six domains connect this preparation to observable practices, while four adoption states distinguish interest from sustained operational use. The propositions direct attention to combinations of commitment, resources, data stewardship, workflow, knowledge, and accountability. The proposed multiple-case inquiry offers a route to assess these ideas in Bangladesh without presuming successful adoption or environmental gains. The framework requires empirical refinement before it can be used as a validated assessment instrument.

DECLARATION OF AI ASSISTANCE

OpenAI Codex assisted source discovery, conceptual development, drafting, and formatting, including the proposed framework and propositions. No primary interview or operational dataset was generated or analyzed for this article.

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