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Sustainable Strategic Operation Through the Implementation of Business Continuity Management System (BCMS) Based on Iso 22301:2019 at XYZ Fertilizer Company

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Abstrak: *Produksi pupuk sangat bergantung pada proses yang terintegrasi, utilitas kritis, fasilitas khusus, dan kemampuan pemulihan yang terkoordinasi. Namun, penelitian terdahulu tentang keberlangsungan bisnis lebih banyak berfokus pada layanan publik, sistem informasi, layanan kesehatan, atau ketahanan organisasi secara umum, sehingga bukti empiris mengenai integrasi persyaratan internasional keberlangsungan bisnis dengan metode perbaikan proses terstruktur pada industri pupuk masih terbatas. Penelitian ini bertujuan mengevaluasi sistem keberlangsungan bisnis eksisting pada Perusahaan Pupuk XYZ, mengidentifikasi prioritas pemulihan, dan merancang target state yang terintegrasi. Studi kasus kualitatif dilakukan melalui wawancara, observasi lapangan, telaah dokumen internal, analisis akar masalah, analisis kesenjangan, analisis dampak bisnis, dan kerangka Define-Measure-Analyze-Improve-Control. Penilaian 26 kriteria menunjukkan 61,5% fully achieved, 34,6% partially achieved, dan 3,8% not achieved, dengan kesenjangan terbesar pada persyaratan operasi. Pemutakhiran analisis dampak mengidentifikasi 13 fungsi bisnis kritis beserta parameter pemulihan, ketergantungan, dan sumber daya kritis. Kebaruan penelitian terletak pada integrasi diagnosis insiden operasional, asesmen kesenjangan berbasis standar, prioritas pemulihan berbasis dampak, dan perbaikan berkelanjutan dalam satu rancangan keberlangsungan bisnis industri pupuk.*

Kata Kunci: *Manajemen Keberlangsungan Bisnis, ISO 22301:2019, Ketahanan Operasional, Analisis Dampak Bisnis, Operasi Berkelanjutan*

Abstract: Fertilizer production is highly dependent on integrated processes, critical utilities, specialized facilities, and coordinated recovery capabilities. However, previous studies have rarely integrated incident-based root-cause analysis, ISO 22301:2019 conformity assessment, updated Business Impact Analysis, and structured improvement within one sustainable-operations study. This study aims to strengthen sustainable strategic operation at XYZ Fertilizer Company through an ISO 22301:2019-based Business Continuity Management System using a qualitative case study and the DMAIC framework. The assessment of 26 criteria found 61.5% Fully Achieved, 34.6% Partially Achieved, and 3.8% Not Achieved, with the largest gaps in Clause 8. The updated analysis identified 13 Critical Business Functions and their recovery priorities. The novelty lies in integrating root-cause analysis, standards-based gap assessment, updated impact analysis, target-state continuity design, and control mechanisms while explicitly linking operational resilience to Sustainable Development Goals 9, 8, 12, and 13.

Keyword: Business Continuity Management, ISO 22301:2019, Operational Resilience, Business Impact Analysis, Sustainable Strategic Operation

INTRODUCTION

Operational continuity has become a strategic requirement for process industries because production reliability depends on interrelated physical assets, utilities, process controls, human resources, suppliers, information, and logistics. In fertilizer manufacturing, a disruption in a single facility may propagate across upstream and downstream processes and influence production volume, product availability, distribution performance, safety, and financial outcomes. Operational resilience therefore extends beyond emergency response: it concerns the organization's capability to maintain or restore priority activities within acceptable time limits while preserving long-term operational sustainability.

Fertilizer Company XYZ is a state-owned-group affiliate operating in the fertilizer and petrochemical sector. Its major production system includes ammonia, urea, NPK fertilizer, hydrogen peroxide, utilities, storage facilities, product handling, and port operations. The production configuration is highly integrated. Utility availability affects production units, production output depends on process control and quality functions, and distribution depends on storage, bagging, dispatch, and port activities. Such interdependencies make continuity planning particularly important because the impact of a disruption can extend well beyond the damaged asset.

The empirical problem emerged from two fire incidents in NPK-related facilities. The first incident in September 2024 occurred in the NPK process area, generated direct material damage of IDR 130,350,620, caused approximately 12 hours of shutdown, and was associated with an estimated 700 tons of potential production loss. Using the 2025 NPK retail ceiling price of IDR 2,300,000 per ton as a conservative proxy, the potential lost-production value was approximately IDR 1.61 billion, producing an indicative total impact of approximately IDR 1.74 billion. The second incident in August 2025 affected NPK Bulk Storage and a transfer-tower area. The repair target was approximately 30 days, direct material damage was estimated at about IDR 1.25 billion, and the period potentially delayed approximately 41,096 tons of NPK production, equivalent to about IDR 94.52 billion under the same proxy. These events demonstrate that business disruption impacts may substantially exceed immediate asset losses.

Business Continuity Management System (BCMS) provides a management framework for preparing an organization to respond to disruption and recover priority activities. Chatzistelios et al. (2022) demonstrated the relevance of ISO 22301:2019 for strengthening organizational continuity and management-system integration, while Religia and Utama (2024) emphasized that a structured continuity framework must connect leadership, planning, support, continuity planning, and improvement. Russo et al. (2025) further highlighted the role of self-assessment in sustaining business-continuity readiness. More broadly, Greenwood et al. (2025) argue that resilience must be embedded as a strategic system rather than treated as a stand-alone response mechanism, and Ghaith et al. (2025) show that organizational resilience is strengthened when decision-making and organizational capabilities are systematically integrated.

The sustainability literature provides a second conceptual foundation. Corrales-Estrada et al. (2021) identify a bidirectional relationship between organizational resilience and sustainability capabilities, indicating that continuity and adaptive capacity support long-term organizational performance. Assarkhaniki et al. (2023) similarly position resilience as an enabling element for sustainable development. Recent manufacturing studies also emphasize that sustainable performance depends on organizational and leadership capabilities, including green innovation, governance, and adaptive processes (Gloria, 2025; Siddiquei et al., 2025). For a fertilizer producer, continuity capability therefore contributes to sustainable strategic operations by reducing vulnerability to prolonged shutdowns and supporting stable production and distribution.

A third stream of literature concerns structured process improvement. Lean Six Sigma and DMAIC have been applied across manufacturing, logistics, healthcare, and industrial process environments to diagnose problems, reduce variability, standardize processes, and sustain improvement (Alarcón et al., 2024; Barbosa et al., 2025; Duc et al., 2025; Irtiza et al., 2025; Jiang et al., 2025; Marques et al., 2025; Reyes et al., 2025; San Antonio et al., 2025; Silva & Goussain, 2025; Simatupang & Nugroho, 2025; Wijaya & Purwanto, 2025; Weraikat et al., 2024; Zourmand et al., 2022). Kumah et al. (2024) also demonstrate the continuing value of the Fishbone Diagram for organizing causal factors in quality-improvement initiatives. These studies show that structured improvement methods are versatile, but their use as a governance sequence for strengthening a standards-based BCMS remains comparatively underexplored.

The research gap lies in the limited empirical integration of four elements within one operational-resilience study: incident-based root-cause diagnosis, ISO 22301:2019 conformity assessment, Business Impact Analysis-based recovery prioritization, and DMAIC-based improvement governance. Existing business-continuity studies often focus on framework design, public organizations, information systems, or pandemic response, while DMAIC studies mainly address quality, waste, logistics, or process efficiency. Empirical studies in fertilizer manufacturing that combine these approaches and translate them into an integrated BCMS target state remain scarce.

Accordingly, the state of the art of this study is the use of ISO 22301:2019 as the normative management-system reference while DMAIC is used as the improvement logic that organizes diagnosis, measurement, analysis, solution design, and control. Business Impact Analysis is not treated as a stand-alone compliance document but as a controlled baseline connecting critical functions, Recovery Time Objectives, Maximum Tolerable Periods of Disruption, interdependencies, resources, continuity strategies, and continuity plans. This configuration distinguishes the study from previous work that evaluates continuity or process improvement separately.

Based on this gap, the study addresses three questions: (1) what is the current level of BCMS conformity at Fertilizer Company XYZ against ISO 22301:2019; (2) which business functions should be prioritized for recovery based on the updated Business Impact Analysis; and (3) what target-state BCMS design can strengthen operational resilience and support sustainable strategic operations? The study therefore aims to assess the existing BCMS, define updated continuity priorities, and formulate an integrated target-state design supported by sustainable control and improvement mechanisms.

METHOD

This research used a descriptive qualitative case-study design at Fertilizer Company XYZ. The object of analysis was the company's Business Continuity Management System, while the participants included managers and functional personnel involved in operational risk management, production, maintenance, occupational safety, information technology, procurement, warehousing, distribution, and continuity planning. The study was conducted from October 2025 to February 2026 at the company's main operational site in western Indonesia.

Primary data were obtained through semi-structured interviews and non-participant field observation. Twenty-six respondents at Vice President, Assistant Vice President, and functional/staff levels participated in the broader data-collection process. Secondary data comprised internal incident reports for 2024 and 2025, BCMS guidelines, BCP and Business

Continuity Strategy documents, organizational structures, previous BIA documentation, emergency procedures, and supporting operational records. Data triangulation was applied by comparing interview statements, field observations, and documented evidence.

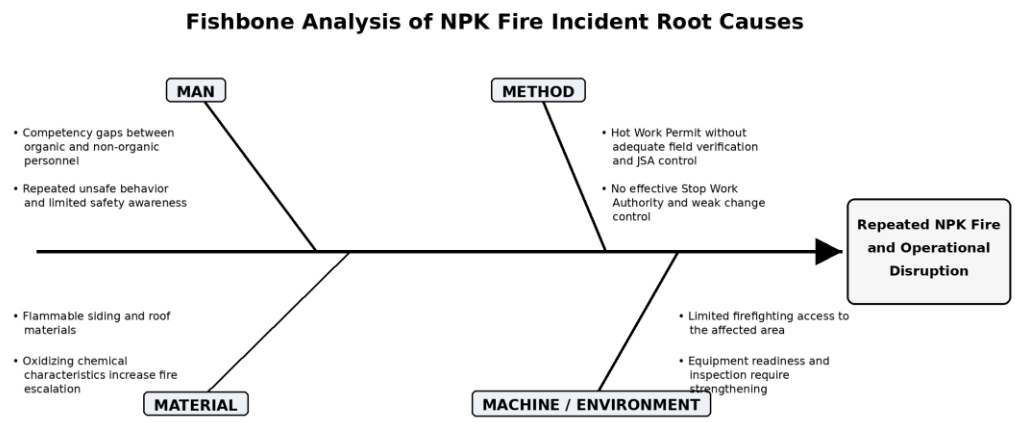
DMAIC was used as the analytical workflow. Define established the disruption problem and BCMS scope; Measure collected process and continuity baseline data; Analyze integrated Fishbone root-cause analysis, ISO 22301:2019 gap analysis, and Business Impact Analysis; Improve translated the findings into a target-state BCMS and supporting procedures; and Control evaluated implementation readiness through structure socialization, awareness training, Table Top Exercise, performance monitoring, internal audit, management review, and corrective-action mechanisms. This use of DMAIC as an improvement sequence is consistent with recent applications across multiple operational contexts (Barbosa et al., 2025; Jiang et al., 2025; San Antonio et al., 2025).

The ISO 22301:2019 gap assessment covered 26 criteria across Clauses 4 to 10. Criteria were classified as Fully Achieved when requirements were met and adequately evidenced, Partially Achieved when implementation existed but remained incomplete in scope, documentation, updating, integration, or execution, and Not Achieved when requirements or sufficient evidence were absent. The BIA assessed disruption impacts across financial, operational/business, customer service, reputation, legal/compliance, and occupational health, safety, and environmental dimensions. Processes producing severe or very severe impacts were classified as Critical Business Functions, after which RTO, MTPD, interdependencies, and critical resources were determined for recovery prioritization.

RESULTS AND DISCUSSION

1. Root Cause Analysis and Current BCMS Conformity Against ISO 22301:2019

The analysis began by examining the operational incidents because continuity-system weaknesses need to be interpreted in relation to real disruption behavior. The Fishbone analysis showed that the NPK incidents reflected multiple causal dimensions rather than a single technical failure. Human factors included competence and awareness gaps across a mixed organic and non-organic workforce. Method factors included weaknesses in Job Safety Analysis, Hot Work Permit verification, change control during work execution, and Stop Work Authority. Material, equipment, and environmental factors included combustible materials, equipment conditions, and restricted access for emergency response. These results support the argument of Kumah et al. (2024) that cause-and-effect analysis is valuable for structuring improvement actions around root causes instead of symptoms.



Source: Researcher's analysis based on internal incident investigation documents (2024-2025)
Figure 1. Fishbone Analysis of NPK Fire Incident Root Causes

The root-cause findings also clarify the distinction between prevention and continuity. Improved work permits, safety controls, competence, and equipment readiness can reduce incident likelihood, but they cannot eliminate residual risk. Once a disruption occurs, the organizational challenge shifts from prevention to maintaining or recovering critical operations. Consequently, preventive recommendations were treated as one layer of control, while BCMS was designed as the resilience layer for response and recovery.

Based on the root-cause analysis, the recommended preventive improvements are directed at the same causal dimensions. For human factors, the company should standardize competency requirements for organic and non-organic personnel, strengthen mandatory Job Safety Analysis control, expand Job Safety Analysis awareness training, complete relevant competency certification, and ensure workforce sufficiency based on workload analysis. For method-related causes, work procedures should be periodically reviewed and socialized, deviations or changes in work execution should require formal authorization, emergency and urgent work categories should be clearly defined, and Stop Work Authority should be institutionalized so that unsafe work can be halted immediately. For machine and material factors, periodic equipment inspection and fit-for-use tagging should be strengthened, while the replacement of flammable siding and roofing with more heat-resistant materials should be technically assessed. These recommendations reduce the probability and escalation of future incidents, while the BCMS complements them by addressing residual risk through structured response, recovery, and continuity arrangements.

The gap analysis across 26 ISO 22301:2019 criteria showed that 16 criteria (61.5%) were Fully Achieved, nine (34.6%) were Partially Achieved, and one (3.8%) was Not Achieved. These results demonstrate that the company already possessed a meaningful continuity foundation rather than starting from zero. Planning and improvement requirements were comparatively strong, and the organization had policies, organizational structures, defined roles, continuity procedures, exercises, internal audits, and management-review mechanisms.

Table 1. Summary of ISO 22301:2019 BCMS Gap Analysis

Clause	Total Criteria	Fully Achieved	Partially Achieved	Not Achieved
Clause 4 - Context of the Organization	4	2	1	1
Clause 5 - Leadership	3	2	1	0
Clause 6 - Planning	3	3	0	0
Clause 7 - Support	5	3	2	0
Clause 8 - Operation	6	2	4	0
Clause 9 - Performance Evaluation	3	2	1	0
Clause 10 - Improvement	2	2	0	0
Total	**26**	**16**	**9**	**1**
Percentage	**100%**	**61.5%**	**34.6%**	**3.8%**

Source: Researcher's analysis based on the BCMS Gap Analysis of Fertilizer Company XYZ

The dominant weakness was Clause 8 on Operation, where four of six criteria remained Partially Achieved. The specific deficiencies concerned BIA updating, integration of BIA and risk assessment with continuity strategies and plans, completeness of resource requirements, designation of alternate personnel, alignment of recovery procedures with RTO and MTPD, and integrated testing. Clause 4 also contained the only Not Achieved criterion, concerning formal identification of relevant interested parties and their continuity-related requirements.

This pattern is significant because operational clauses translate management-system intent into executable continuity capability. Chatzistelios et al. (2022) emphasize that a continuity management system must connect organizational management practices to operational readiness, while Religia and Utama (2024) show that continuity planning is effective when organizational, planning, and operational components are integrated. Russo et al. (2025) similarly position structured assessment as a recurring mechanism for identifying readiness gaps. The company's 61.5% Fully Achieved score therefore indicates a solid baseline, but the concentration of partial achievement in Clause 8 shows that documentation maturity had not yet been fully converted into recovery capability.

2. Recovery Priorities Based on the Updated Business Impact Analysis

The previous company BIA identified 24 Critical Business Functions. However, the gap assessment indicated that BIA information required updating because business processes, organizational arrangements, technologies, resources, and interdependencies had changed. The updated assessment therefore revalidated process criticality within the operational-disruption scope and produced 13 CBFs for focused continuity planning.

The revised CBF set covers production, utilities, storage, NPK and hydrogen-peroxide operations, bagging, product dispatch, port operations, process monitoring, and quality control. The result is not simply a numerical reduction from 24 to 13 functions; it is a refinement intended to establish a more decision-useful baseline for recovery. Each CBF was associated with impact progression, RTO, MTPD, internal and external dependencies, and the minimum critical resources required to maintain or restore the activity.

Table 2. Critical Business Functions Identified Through the Updated BIA

No.	Department	Critical Business Function
1	Plant Operations 1	Urea Production
2	Plant Operations 1	Ammonia Production
3	Plant Operations 1	Provision of Energy Utilities, Air, and Water
4	Plant Operations 1	Ammonia Storage
5	Plant Operations 2	NPK Operations
6	Plant Operations 2	NPK Facility
7	Plant Operations 2	H2O2 Operations
8	Plant Operations 3	Urea Product Bagging
9	Plant Operations 3	Urea Product Dispatch
10	Plant Operations 3	NPK and H2O2 Product Dispatch
11	Plant Operations 3	Port Operations
12	Process and Energy Control	Daily Production Process Monitoring
13	Process and Energy Control	Production Quality Control

Source: Updated Business Impact Analysis results

Interdependency analysis was particularly important. Utility availability is a prerequisite for multiple production functions; process monitoring and quality control influence safe and compliant production; and finished-product continuity depends on storage, bagging, dispatch, and port processes. A recovery plan based solely on organizational hierarchy would therefore be inadequate because the technically highest-priority function may depend on another activity that must be restored first. The BIA addresses this issue by connecting impact severity with dependency logic.

RTO and MTPD serve different but complementary roles. RTO establishes the target time for restoring an activity to an acceptable level, whereas MTPD represents the maximum disruption period beyond which consequences become unacceptable. When these time parameters are linked to interdependencies and resource requirements, the BIA becomes a recovery-decision instrument rather than an audit artifact. This interpretation is consistent with recent resilience literature that emphasizes dynamic capability, data-informed decision-making, and system-level recovery rather than static documentation (Ghaith et al., 2025; Greenwood et al., 2025).

The updated BIA also creates a sustainability linkage. Corrales-Estrada et al. (2021) argue that organizational resilience supports continuity and long-term sustainability, and Assarkhaniki et al. (2023) show that resilience contributes to sustainable-development capability. In the fertilizer context, faster restoration of production, distribution, and supporting functions can reduce the economic and service consequences of disruption while preserving the company's contribution to supply reliability.

3. Target-State BCMS for Operational Resilience and Sustainable Strategic Operations

The target-state design was developed by synthesizing root-cause findings, ISO 22301:2019 gaps, and the updated BIA. The design deliberately avoids treating new procedures as the final output. Instead, it establishes an integrated management architecture consisting of governance, controlled continuity baselines, continuity strategy, end-to-end plans, exercises, performance evaluation, and continual improvement.

The governance component requires clear ownership of the BCMS and continuity response structure. Roles include the BCMS Coordinator, BC Leader, Section Chiefs, primary persons, alternate persons, RACI assignments, and a validated call tree. The gap analysis showed that alternate-person arrangements were incomplete; therefore, the target state reduces single-person dependency by formally defining replacement personnel and competence requirements. This reflects the systems perspective proposed by Greenwood et al. (2025), where resilience depends on coordinated organizational structures rather than isolated contingency documents.

The second component treats BIA and CBF information as controlled management-system data. Critical functions, RTOs, MTPDs, interdependencies, and minimum resource requirements should be subject to formal approval, review cycles, change control, and revalidation after significant process or organizational changes. This mechanism prevents continuity plans from relying on outdated assumptions and links the continuity system to operational change management.

The third component integrates BIA with the Business Continuity Strategy. Recovery solutions should be derived from the actual priority and tolerance profile of each CBF and should consider minimum personnel, alternative locations, technology, communication, transportation, materials, facilities, utilities, and third parties. Strategy selection therefore becomes evidence-based rather than generic.

The fourth component strengthens the Business Continuity Plan from activation through response, recovery, and restoration. The proposed system includes activation criteria, decision authority, command-center arrangements, call trees, incident logs, recovery checklists, resource mobilization, communication requirements, and scenario-based playbooks. Playbooks are particularly valuable because they translate high-level continuity procedures into executable actions for prioritized disruption scenarios.

The fifth component is the Control mechanism. Structure socialization, BCMS awareness training, and Table Top Exercises were used to validate implementation readiness. The exercise indicated that the response structure could generally operate in an organized manner, while communication, call-tree clarity, role coordination, and recovery documentation still required refinement. Exercises therefore function as tests of the assumptions embedded in BIA, strategy, and BCP rather than as stand-alone compliance events.

This control logic is reinforced by evidence from recent process-improvement research. DMAIC has been used to enhance manufacturing performance, logistics, healthcare standardization, technical processes, and operational quality (Alarcón et al., 2024; Barbosa et al., 2025; Duc et al., 2025; Irtiza et al., 2025; Jiang et al., 2025; Marques et al., 2025; Reyes et al., 2025; San Antonio et al., 2025; Silva & Goussain, 2025; Simatupang & Nugroho, 2025;

Wijaya & Purwanto, 2025; Weraikat et al., 2024; Zourmand et al., 2022). The present study extends that logic by using DMAIC to strengthen a management system: Analyze identifies continuity weaknesses, Improve develops the target state, and Control creates a feedback loop through exercises, audits, management review, KPIs, and corrective actions.

Table 3. Summary of the Proposed Target-State BCMS

Area	Main Gap	Target State
Governance	Roles and alternate personnel are incomplete	Approved BCMS structure, primary/alternate personnel, RACI, validated call tree
BIA/CBF Baseline	Continuity baseline requires updating	Controlled and periodically reviewed CBF, RTO, MTPD, dependency, and resource data
Continuity Strategy	BIA is not fully translated into recovery solutions	Strategies and resources derived from impact tolerance and dependencies
Business Continuity Plan	Recovery mechanisms are not fully end-to-end	Activation, response, recovery, restoration, playbooks, logs, checklists
Evaluation and Exercises	Testing and monitoring are not fully integrated	Table Top Exercise, functional drills, KPIs, internal audit, management review
Continual Improvement	Lessons learned are not consistently closed	Corrective actions, change logs, verification, periodic BIA/BCP updates

Source: Researcher's synthesis based on RCA, gap analysis, BIA, and ISO 22301:2019

The proposed implementation sequence is phased. In the short term, the company should finalize governance, primary and alternate personnel, RACI assignments, and call-tree validation. In the medium term, the emphasis should shift to updating BIA/CBF data, validating RTO and MTPD, integrating BIA with continuity strategy and related emergency/recovery plans, and strengthening competence through awareness training. In the longer term, recurring exercises, internal audits, management reviews, KPI monitoring, and corrective-action closure should institutionalize continual improvement.

From a sustainable strategic-operations perspective, this design connects operational resilience with organizational sustainability. Stable fertilizer production and distribution are not only efficiency concerns; they support the continuity of a strategic supply function. The resilience-sustainability relationship identified by Corrales-Estrada et al. (2021) and Assarkhaniki et al. (2023) is therefore operationalized through measurable recovery priorities and controlled continuity mechanisms. The broader management literature similarly emphasizes that resilient and sustainable performance depends on integrated organizational capabilities, leadership, innovation, and adaptive processes (Gloria, 2025; Siddiquei et al., 2025).

The sustainability contribution is also aligned with the Sustainable Development Goals. The strongest linkage is with SDG 9 (Industry, Innovation and Infrastructure), because the proposed BCMS strengthens resilient industrial infrastructure and the continuity of critical production functions. SDG 8 (Decent Work and Economic Growth) is supported through clearer emergency roles, competency development, safer response arrangements, and the protection of productive capacity during disruption. SDG 12 (Responsible Consumption and Production) is supported through more controlled production processes, prevention of disruption-related waste and losses, and structured recovery of critical resources. SDG 13 (Climate Action) is positioned as a supporting linkage through organizational resilience and preparedness for climate-related or disaster-related disruptions; this study does not directly measure emissions reduction. Accordingly, BCMS contributes to sustainable strategic operation not only by reducing downtime but also by strengthening the company's capacity to maintain safe, responsible, and resilient industrial operations over the long term.

The novelty of this study is the integrated pathway that links incident diagnosis, standards-based conformity assessment, impact-based recovery prioritization, and DMAIC-based continual improvement within a single BCMS design for fertilizer manufacturing. Rather than treating ISO 22301:2019 as a checklist or BIA as a static compliance document, the study positions BIA/CBF data as a controlled operational baseline that drives continuity strategies and BCP actions, while DMAIC provides the governance logic for maintaining and improving that system. This integrated configuration provides a practical contribution for high-dependency process industries in which operational disruptions can create cascading production and distribution impacts.

CONCLUSION AND SUGGESTIONS

Conclusion

The study concludes that XYZ Fertilizer Company has established a substantive BCMS foundation, but operational maturity must be strengthened to convert documented arrangements into reliable continuity capability. The ISO 22301:2019 gap analysis identified 61.5% Fully Achieved, 34.6% Partially Achieved, and 3.8% Not Achieved, with the largest gaps in Clause 8 on Operation. The updated Business Impact Analysis identified 13 Critical Business Functions and established recovery priorities through RTO, MTPD, interdependencies, and critical-resource requirements. The proposed target-state BCMS integrates governance, updated BIA/CBF baselines, continuity strategies, end-to-end BCP, response structures, exercises, performance monitoring, management review, and CAPA. This integrated approach strengthens sustainable strategic operation by linking operational resilience with SDG 9 through resilient industrial infrastructure, SDG 8 through workforce readiness and protection of productive capacity, SDG 12 through more controlled and responsible production, and SDG 13 through resilience and preparedness for disruptive events. Therefore, the implementation of an ISO 22301:2019-based BCMS provides both an operational and sustainability mechanism for maintaining critical fertilizer production and distribution under disruption.

Limitations

This study has several limitations. It is a single-company qualitative case study within one strategic manufacturing context, so the findings should not be generalized directly to all fertilizer, petrochemical, or process-industry organizations. The assessment relies on the availability and quality of internal documents, interview information, and observations during a defined study period. The updated BIA focuses on the operational scope selected for the project and does not quantify every potential disruption scenario, supply-chain shock, cyber event, or external hazard. In addition, the target-state design and exercise results evaluate implementation readiness rather than long-term post-implementation performance across multiple actual disruptions.

Suggestions

Future research should test the proposed integration of ISO 22301:2019, BIA, and DMAIC in other process industries and compare maturity patterns across organizations. Longitudinal research could evaluate whether repeated exercises, audits, and BIA updates improve actual RTO achievement and reduce recovery variance over time. Further studies may also integrate quantitative risk modeling, system dynamics, supply-chain resilience analysis, digital-twin or simulation approaches, and data-driven decision tools to examine cascading dependencies more precisely. For Fertilizer Company XYZ, the immediate managerial priority is to institutionalize the proposed target state through formal governance approval, periodic

BIA revalidation, continuity-strategy integration, validated alternate personnel, scenario-based exercises, and corrective-action closure.

Author Contributions

Febiko Ramadina contributed to research conceptualization, data collection, document review, analysis, interpretation, and manuscript preparation. Tukhas Shilul Imaroh contributed to conceptual refinement, academic supervision, interpretation of findings, critical review, and manuscript improvement. Both authors reviewed and approved the final manuscript.

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