

Transforming Contingency Plans into BPMN-Based Disaster Management Workflows: A Design Science Research Study in Agam Regency

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Abstract. This study addresses the operational bottlenecks in regional disaster management caused by static, narrative-based Contingency Plans. It aims to bridge the semantic gap between legal bureaucratic prose and machine-readable BPMN workflow specifications to facilitate modern e-Government integration in Agam Regency. We applied a Design Science Research (DSR) methodology to systematically extract and transform passive policy texts into structured Business Process Model and Notation (BPMN) workflows. The resulting artifact was then syntactically validated using ISO/IEC 19510 conformance checking alongside proposed expert evaluation criteria. The empirical transformation successfully reduced ambiguous legal instructions into precise operational logic, enforcing strict accountability boundaries. Although syntax validation confirmed the model's syntactic correctness, actual deployment faces anticipated non-technical hurdles; potential governance barriers, such as data silos and resistance to automated discretionary control, were inferred from the transformation process. This research provides an alternative perspective on public policy formulation by treating contingency documents not merely as passive archives, but as executable-ready "machine-readable workflow specifications." It offers a conceptual blueprint for structuring emergency response protocols in regional administrations. The resulting artifact represents a conceptual workflow design and has not yet been deployed or tested in a process engine.

Keywords: e-Government; Disaster Management; BPMN; Contingency Plan; Workflow Modeling; Design Science Research

1. INTRODUCTION

Although the concepts of e-Government and digital government have been widely adopted across various levels of public administration, their application within the domain of emergency management remains sporadic. Local governments increasingly rely on software integration to accelerate coordination. However, the effectiveness of current early warning systems and resource mobilization is hampered by their underlying procedural foundation [1], [2]. Command reference documents, such as Contingency Plans and Standard Operating Procedures (SOPs), are typically documented in voluminous narrative text formats. Agam Regency was selected as the case study not merely due to its spatial vulnerability, but because its official Contingency Plan (2023–2027) involves extensive cross-agency coordination among multiple Regional Apparatus Organizations (OPDs) across overlapping coastal and mountainous jurisdictions. This characteristic provides a highly suitable empirical case for testing policy-to-workflow transformation, representing the bureaucratic ambiguity common in decentralized disaster governance in developing nations.

This reliance on static text documents may contribute to operational ambiguity in the field. Contingency plans comprising hundreds of pages of bureaucratic prose are highly susceptible to assignment ambiguity. Instructions such as "relevant agencies coordinate rapidly" fail to explicitly define boundaries of authority [3], [4]. When disaster strikes, the lack of clear articulation regarding actors and timeframes Service Level Agreements triggers structural confusion, potentially resulting in delayed responses or blame-shifting among Regional Apparatus Organizations (OPDs). Furthermore, this narrative format is inaccessible to and unprocessable by machines (machine-readable), making it difficult for government software engineers to translate these legal procedures into workflow specifications for intelligent e-Government control systems. It is essential to strictly distinguish between four main concepts: (1) document digitization (converting physical archives into digital formats), (2) workflow modeling (structuring activities, actors, and decision logic into visual representations), (3) workflow automation (executing specific processes automatically via software), and (4) process orchestration (deploying models through a process engine in an operational environment). This study focuses exclusively on design-level workflow modeling and formalization, rather than operational workflow automation or process-engine execution.

Much of the prior literature tends to assume that the digitalization of infrastructure automatically resolves disaster response coordination issues. Recent studies [5], [6] rely heavily on purely technological approaches through the integration of Internet of Things (IoT) sensors and geospatial detection algorithms. However, this approach often overlooks the underlying logic of bureaucratic workflows. Paradoxically, the centrality of workflow modeling is actually supported by public sector Business Process Management (BPM) literature [7], which concludes that transparency and service speed depend more on the clarity of business processes than on tool sophistication. Unfortunately, modeling using Business Process Model and Notation (BPMN) in government is largely deployed for routine civil services like licensing, and has barely been touched to engineer rapid-onset, cross-institutional crisis scenarios [1], [8], [9]. Attempts to extract government workflows from historical data using Process Mining [10] also have blind spots; this technique is incapable of modeling disaster response designs for extreme events where event logs are not previously available.

The fundamental paradox in current e-Government literature is the high investment in post-disaster technologies (such as smart sensors [5], [6] and high-level data fusion [11], [12] without a commensurate effort to digitalize the internal bureaucratic logic that drives these technologies. Although several qualitative studies [13], [14] have successfully identified stakeholders and communication barriers, the majority of frameworks still treat Contingency Plans as passive policy documents that cannot be executed by machines. It is this literature gap that positions regulation-based process modeling as the critical foundation for structuring executable-ready digital government services [1], [2], [15].

Responding to the scarcity of empirical studies on integrating text-based policies into systems, this research seeks to answer three specific research questions: (RQ1) How can passive narrative instructions from regional contingency documents be reduced into strict operational logic fragments? (RQ2) How can a BPMN representation be designed that accommodates the asynchronous nature of bureaucratic actors in responding to dual crises? (RQ3) What are the latent weaknesses of regulation-based process modeling when validated as a computational structure? Accordingly, the objective of this study is to develop and conceptually validate a BPMN-based workflow artifact that systematically transforms narrative disaster contingency provisions into structured, machine-readable

process specifications for future e-Government implementation. This artifact serves as a conceptual process blueprint, rather than a deployed operational system, illustrating the integration of PAIS (Process-Aware Information Systems) principles, where public policy is designed for digital execution.

2. RESEARCH METHODOLOGY

2.1. Design Science Research Framework

The methodological contribution flow of this research is briefly mapped in Figure 1, which illustrates the journey from emergency problem formulation to e-Government architecture specification. Fundamentally, this research is executed through a Design Science Research (DSR) framework [16]. This methodology is positioned not merely to observe how government bureaucracies respond to disasters, but to actively create artifacts (in the form of BPMN workflows) to reverse-engineer the coordination system. The use of DSR here is driven by the epistemological view that current disaster management legal documents act as conceptual architectures that have not yet been computationally structured. Therefore, design intervention is needed to bridge the gap between legal text and its software implementation.

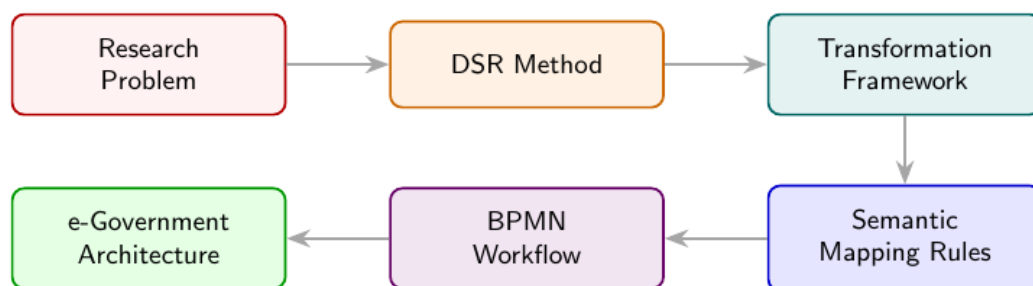


Figure 1. Research Contribution Diagram

The transformation from ambiguous legal documents into computational architecture cannot rely on simple mechanical interpretation. Therefore, we executed a nine-phase framework Figure 2 designed to deconstruct bureaucratic prose.

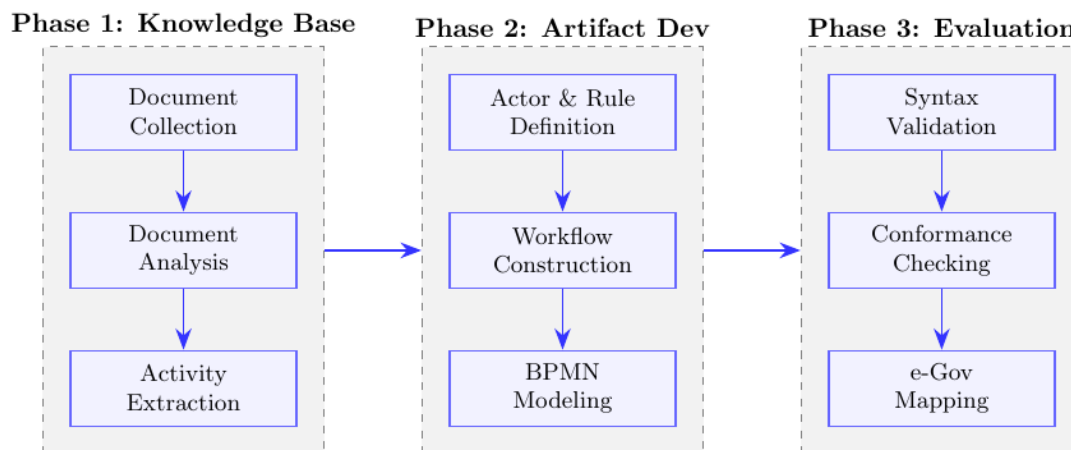


Figure 2. Design Science Research (DSR) Workflow for Policy Transformation

Table 1. Design Science Research (DSR) Framework Mapping

DSR Step	Application in this Study
Problem Identification	Documenting the operational bottleneck where narrative Contingency Plans cause assignment ambiguity during emergency response.
Objectives of Solution	To bridge the semantic gap by translating bureaucratic prose into machine-readable workflow specifications.
Design & Development	Using Open Coding to extract activities and modeling the emergency response logic in BPMN via Camunda Modeler.
Demonstration	Showcasing the conceptual BPMN architecture using the Agam Regency Contingency Plan as the primary case study.
Evaluation	Validating the artifact through ISO/IEC 19510 syntactic conformance checking and expert assessment criteria.
Communication	Disseminating the blueprint to government software engineers and public policy researchers for future e-Government integration.

2.2. Research Materials and Source Documents

The material object of this research focuses on the official Contingency Plan Document for Tsunami and Landslide Threats in Agam Regency (2023–2027) [17]. Data was extracted exclusively from primary printed documents to ensure that e-Government algorithms are

derived directly from prevailing legal regulations rather than programmer opinion. The primary documents used in this study are detailed in Table 2.

Table 2. Primary Source Documents for Activity Extraction

ID	Document Title	Institution	Year	Role in Extraction
S1	Agam Contingency Plan 2023 - 2027[17]	Pemkab Agam	2023	Primary source for disaster scenarios
S 2	BPBD Standard Operating Procedures [18]	BPBD Agam	-	Operational response procedures
S 3	Head of BNPB Regulation No. 4/2008 [19]	BNPB	200 8	National regulatory basis

2.3. Document Analysis and Open Coding

The initial three phases of the DSR framework Document Collection, Document Analysis, Activity Extraction function as a strict filtration mechanism. We utilized an Open Coding method to separate conceptual definitions from actionable clauses. The coding unit was defined at the clause and paragraph level. The procedure involved two independent coders who systematically extracted action verbs, identified conditions, and assigned them to specific bureaucratic roles. Because we did not calculate a formal statistical inter-coder agreement coefficient (e.g., Cohen's Kappa), coding discrepancies were resolved through a collaborative consensus-building process involving a third disaster management practitioner. This triangulated approach ensured that the operational logic remained faithful to field realities. A representative example of this coding translation is provided in Table 3. To ensure reproducibility, the full activity extraction matrix and clause-to-BPMN mapping are provided as Supplementary Materials S1 and S2.

Table 3. Example of Open Coding Translation from Legal Text to BPMN

Source Clause	Code	Actor	Condition	BPMN Element
"TRC immediately conducts rapid assessment at the disaster location"	Conduct rapid assessment	TRC	Disaster occurs	Task

Source Clause	Code	Actor	Condition	BPMN Element
"If the situation worsens coordinate with BPBD""	Coordinate with BPBD	TRC	Worsening situation	Exclusive Gateway

2.4. Activity Extraction and Semantic Rule Formalization

Following the coding process, the actor identification and business rule abstraction phase commenced. Rule extraction required researchers to convert normative parameters (such as "coordinate if an emergency situation arises") into conditional *if-then* expressions. This presents an analytical challenge given that conventional regulations rarely provide deterministic numerical thresholds. To guide the synthesis of artifacts from the document extraction phase to machine-executable specifications, this research formulated five Design Principles Table 4.

Table 4. Design Principles for Contingency Plan Transformation

ID	Design Principle
DP1	Operational Activity Mapping: Operational actions in the contingency plan must be explicitly transformed into standalone BPMN tasks.
DP2	Organizational Boundary: The boundaries of organizational or specific agency responsibilities are represented as autonomous swimlanes.
DP3	Conditional Routing: Bureaucratic prerequisite clauses or decision branches must be converted into computational logic gateways.
DP4	Inter-Agency Synchronization: Inter-agency coordination and communication are strictly modeled using message flows.
DP5	Executable Rule Abstraction: Managerial decision rules are conceptually represented as executable logic bound to business rules.

Relying on DP1 through DP5, the transformation process is reduced into basic Semantic Mapping Rules, as outlined in Table 5.

Table 5. Semantic Mapping Rules: Text Pattern to BPMN Element

Text Pattern	BPMN Element	Rationale
Verb Activity (e.g. "Evacuate")	Task	Represents an atomic unit of work.

Text Pattern	BPMN Element	Rationale
Sequential Statement (e.g. "Then")	Sequence Flow	Defines chronological execution.
Conditional Statement (e.g. "If")	Gateway	Directs workflow based on data state.
Responsible Agency (e.g. "Health Agency")	Swimlane	Defines organizational resource boundaries.
Information Exchange (e.g. "Report to")	Message Flow	Denotes inter-pool communication.
Trigger Event (e.g. "When earthquake occurs")	Start Event	Initializes the instance.
Completion Event (e.g. "Finished")	End Event	Terminates the workflow instance.

2.5. BPMN Modeling and Validation Procedure

The engineering stages continued with Workflow Construction and visual representation in BPMN Modeling. Supported by Camunda Modeler[20], an enterprise process modeling software, the cleaned activity matrix was translated into Pools, Lanes, Tasks, and Gateways. On a macro level, the hierarchy of empirical transformation stages is represented in Figure 3.

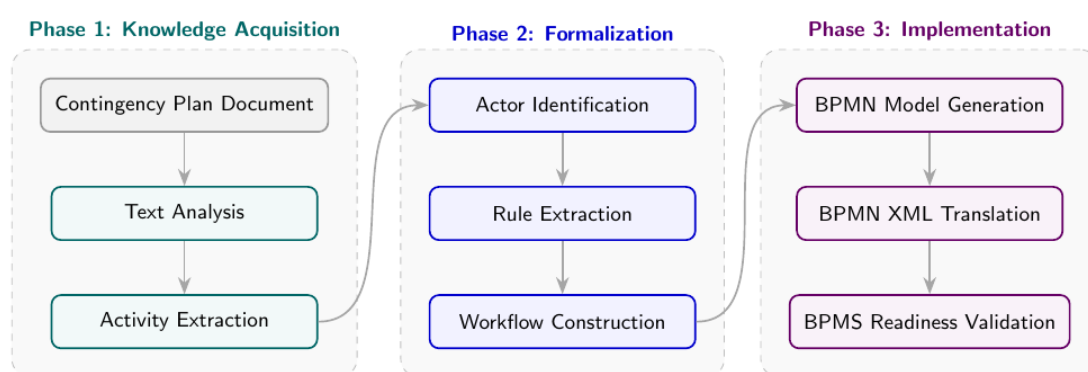


Figure 3. Contingency Plan Transformation Framework

The model validation phase does not aim to prove that this model will be politically accepted without resistance, but rather to verify its structural compliance. Algorithmic

conformance checking was employed to ensure that the designed XML model is syntactically sound and free from computational deadlocks based on ISO/IEC 19510 [21] guidelines, utilizing Camunda's [20] built-in validation engine (Linter). Finally, in the e-Government Mapping phase, the researchers formulated which boundaries of these business processes have the potential to be automated (Service Tasks) and which absolutely require human verification (User Tasks).

3. RESULTS AND DISCUSSION

3.1. Extraction Nuances from the Contingency Plan

The Contingency Plan Document of Agam is structured as a government administrative manuscript binding approximately 15 Regional Apparatus Organizations (OPDs), vertical institutions (Military/Police), and volunteer entities. The modeled scenarios are highly extensive, including the establishment of a Disaster Emergency Response Command (KTDB) with a centralized hierarchical structure where the Regent acts as the Incident Commander. However, when this document was dissected using a process engineering lens, we discovered numerous textual translation obstacles. The characteristics of regional bureaucratic prose are fraught with unspecific delegations and vague time parameters. Figure 4 illustrates a concrete example of this semantic abstraction, showing how a legal paragraph is reduced into logical components.

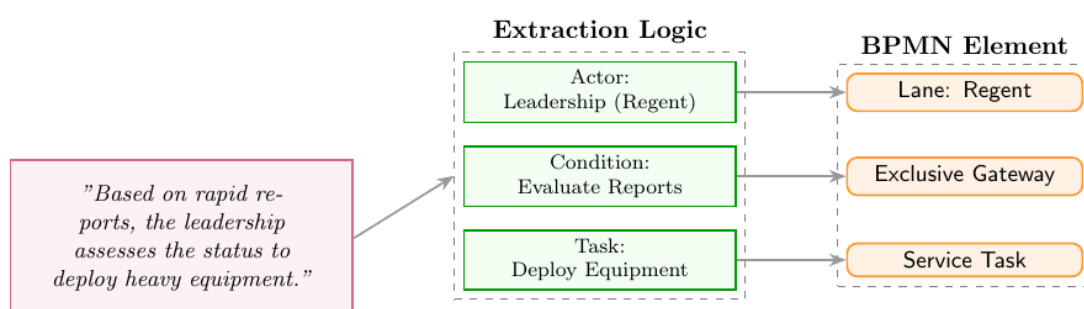


Figure 4. Text-to-BPMN Semantic Mapping Process

To standardize this transformation, we developed a Traceability Matrix that systematically translates legal clauses into computational elements, as detailed in Table Table 6.

Table 6 Traceability Between Contingency Plan and BPMN

Text Clause	Extracted Activity	Actor	Semantic Rule	BPMN Element
The Regent assigns TRC to deploy...	Visual rapid assessment	Regent --> TRC	Delegation (Handoff)	Message Flow / Task
If extreme rainfall intensity...	Evaluate rainfall	BMKG / Sensor	Conditional (If-Then)	Exclusive Gateway
Public Works and Health Agency simultaneously...	Emergency mobilization	Public Works, Health Agency	Concurrency (AND)	Parallel Gateway
If tsunami early warning is active...	Sound the siren	Pusdalops	Event Trigger	Conditional Start Event
Fail to reach location within 2 hours...	Failure report	TRC	Exception / Timeout	Boundary Timer Event

Subsequently, Table 7 and Table 8 demonstrate a portion of the output from this systematic reduction process, converting lengthy descriptive paragraphs into single functional tasks and actor identifications.

Table 7 Extracted Activities from the Contingency Plan

Activity ID	Activity Description	Responsible Actor	Process Phase
ACT-01	Analyze rainfall intensity parameters & ground movement	BMKG / Automated Sensor	Early Warning
ACT-02	Conduct rapid assessment at landslide-prone locations	BPBD Rapid Response Team (TRC)	Preparedness
ACT-03	Compile technical recommendations for emergency status	BPBD Chief Executive	Decision Making
ACT-04	Formally declare the Disaster Emergency Response Status	Regent / Regional Head	Authorization
ACT-05	Sound the tsunami early warning siren (EWS)	Operations Control Center (Pusdalops)	Emergency Action

Activity ID	Activity Description	Responsible Actor	Process Phase
ACT-06	Deploy heavy equipment (excavators) for access clearing	Public Works Agency (PU)	Response/Logistics
ACT-07	Establish emergency medical post at evacuation shelters	Health Agency	Response/Medical

Table 8. Identified Stakeholders and Roles

Stakeholder	Organizational Role	Responsibilities
Regent	Incident Commander	Authorizes disaster status declaration mass resource deployment.
Head of BPBD	Operations Manager	Tactical synchronization rapid, assessment report verification, and technical recommendations.
TRC BPBD	First Responders	Validates visual information at the disaster site (ground truth assessment).
Pusdalops	Information Hub	Monitors BMKG sensors, disseminates early warnings, initial logistics command.
Health Agency	Specialized Support	Medical triage, ambulance mobilization, post-disaster trauma management.
Public Works	Heavy Infrastructure	Heavy equipment mobilization, restoring cut-off road access for logistics.
Military/Police	Security & Evacuation	Forced evacuation (search and rescue), securing the affected area.

The parsing of Business Rules, as shown in Table 9, confirms that government documents fundamentally house an *if-then* algorithmic framework. However, in extracting Table 9, the researchers were forced to make assertive interpretations of phrases such as "if the situation deteriorates" into more systemic metrics. This semantic abstraction process indicates that, in the analyzed case, the narrative structure of the documents requires additional abstraction before it can be represented as a formal workflow for e-Government adoption.

Table 9. Business Rules Extracted from the Document

RuleID	Rule Description	Impact on Process Flow
BR-01	IF earthquake > 7.0 SR AND potential tsunami	Triggers parallel immediate response (Siren sounds without needing Regent authorization).
BR-02	IF extreme rainfall intensity for > 3 hours	Forces system to send a rapid assessment assignment notification to the BPBD TRC lane.
BR-03	IF rapid assessment report shows casualties/destroyed infrastructure	Process route (Gateway) switches to the "Full Emergency" path activates total logistical mobilization.
BR-04	IF no casualties, but secondary threat is high	Process route switches to "Emergency Standby" path partial deployment of specific agencies.

3.2. BPMN Architecture and Implementation Trade-offs

The conversion of activities into BPMN notation (as illustrated in Figure 5 reorganizes the architecture of information flow that has historically been isolated within sectoral egos. The resulting model maps Agam Regency as the central Pool, with swimlanes strictly delineating the jurisdiction of each agency (e.g., Regent, Health Agency, BPBD). This architecture conceptually demonstrates how Parallel Gateways can break the deadlock of hierarchical approval chains, allowing evacuation instructions to be parallelized across multiple institutions simultaneously without waiting for physical letter dispositions.

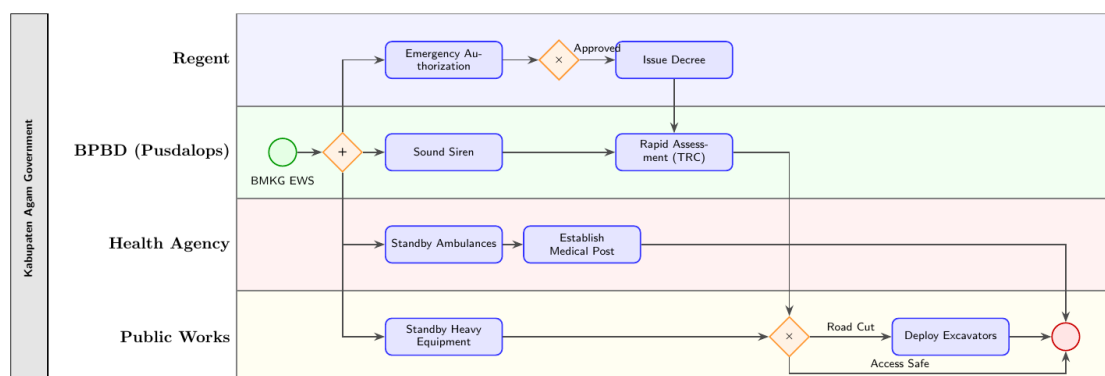


Figure 5 Business Process Model and Notation (BPMN) Architecture for Emergency Response

3.3. Validation and Evaluation

To ensure the robustness of the resulting DSR artifacts, we established a two-tier evaluation framework: Tier 1 for Expert Evaluation and Tier 2 for Technical BPMN Validation. Neither tier constitutes process-engine execution testing. For Tier 1, we conducted an empirical expert validation involving three purposefully selected independent panels: a Business Process Management (BPM) academic expert with over 10 years of experience (V1), a Disaster Management practitioner from a central agency with over 15 years of experience (V2), and a BPBD Authority Official with over 10 years of field experience (V3). Each expert independently assessed the artifact across five criteria using a 5-point Likert scale. The mean score for each criterion was calculated across the three evaluators, and qualitative comments were coded into design recommendations. As summarized in *Table 10*, the model scored consistently across all criteria (mean > 4.3), indicating its alignment with the operational reality of bureaucracy and software engineering. Qualitative feedback from V2 and V3 emphasized the critical need for fallback communication channels, which we incorporated into the final discussion.

Table 10. Expert Validation Results (Scale 1-5)

Criteria	V1	V2	V3	Mean	Qualitative Feedback (Summary)
Correctness	5	4	5	4.67	Flow logic is sound
Completeness	4	4	5	4.33	V1 noted some implicit actors could be merged
Consistency	5	5	4	4.67	Terminology aligns perfectly with the standard contingency plan document.
Usability	5	4	4	4.33	V3 emphasized the need for a simplified dashboard view for commanders.
Applicability	4	5	4	4.33	High potential, but V2/V3 stressed the importance of fallback communication if API fails.

For Tier 2, the validation identified no BPMN syntactic errors or XML well-formedness errors in the inspected artifact based on ISO/IEC 19510 [21] schema validation. However, runtime deadlock behavior was not evaluated through process-engine execution. This

syntactic quality evaluation, as summarized in Table 11 is an essential preliminary step before deploying the model into a process engine.

Table 11. BPMN Validation Results

Validation Item	Tool	Criteria	Errors	Warnings	Result
BPMN Syntax	Camunda Modeler 5.20.0	No syntax errors	0	0	Pass
XML Schema	XML/BPMN Validator	Well-formed	0	--	Pass
Traceability	Matrix Cross-check	Complete Mapping	0	--	Pass
Semantic Correctness	3 Independent Experts	5-point Likert Scale	--	--	Mean 4.3
Pragmatic Quality	3 Independent Experts	Qualitative Assessment	--	--	Positiv e

To further demonstrate the machine-readability of the artifact, Figure 6 provides a representative excerpt of the BPMN XML artifact, illustrating how theoretical business rules are encoded into executable boundary timer events and parallel gateways. The complete BPMN 2.0 XML file is provided as Supplementary Material S3. It is important to note that the `isExecutable="true"` attribute in the XML indicates that the BPMN process is configured as an executable process definition at the modeling level; it does not indicate that the model has been deployed to or executed by a process engine.

```
<?xml version="1.0" encoding="UTF-8"?>
<bpmn:definitions xmlns:bpmn="http://www.omg.org/spec/BPMN/20100524/MODEL"
  id="Definitions_1">
  <bpmn:process id="Process_AgamDisasterResponse" isExecutable="true">

    <!-- Automated Parallel Gateway for Immediate Response -->
    <bpmn:parallelGateway id="Gateway_ParallelResponse" />
    <bpmn:sequenceFlow id="Flow_1" sourceRef="Gateway_ParallelResponse" targetRef="Task_Siren" />
    <bpmn:sequenceFlow id="Flow_2" sourceRef="Gateway_ParallelResponse" targetRef="Task_TRC" />

    <!-- Boundary Timer Event for SLA Enforcement -->
    <bpmn:boundaryEvent id="Event_TimerEscalation" attachedToRef="Task_HealthAgency">
      <bpmn:timerEventDefinition>
        <bpmn:timeDuration>PT2H</bpmn:timeDuration>
      </bpmn:timerEventDefinition>
    </bpmn:boundaryEvent>

  </bpmn:process>
</bpmn:definitions>
```

Figure 6. Actual XML snippet extracted from the generated BPMN 2.0 artifact demonstrating executable parallel gateways and SLA timer boundaries.

While syntax verification guarantees that the model complies with ISO/IEC 19510 [21], it is crucial to distinguish between syntactic correctness and execution readiness. A syntactically flawless BPMN model may still fail during runtime if the encoded business rules do not reflect the dynamic nature of emergency response. For example, rigid Service Level Agreements (SLAs) can cause process deadlocks in the field. To mitigate this, our conceptual model incorporates Boundary Timer Events to automatically escalate tasks if an agency fails to respond within a specified timeframe, and Manual Override mechanisms to allow human commanders to bypass automated flows when unpredictable field conditions demand discretionary interventions. Emergency response workflows differ from routine administrative workflows because communication infrastructure may become unavailable, activities may require manual intervention, and predefined paths may need to be overridden. Therefore, future executable implementations should incorporate fallback communication channels, offline operating modes, exception paths, escalation mechanisms, timer events, and manual override capabilities.

Beyond technical modeling, transitioning from narrative policies to executable Business Rules engines involves significant anticipated structural barriers. While our study focuses on conceptual modeling, e-Government literature suggests that the implementation of such BPMN-derived XML code often assumes that inter-organizational interoperability runs smoothly. However, data silos between local government agencies are widely recognized as a primary theoretical hurdle in data sharing. Furthermore, automating decision-making workflows requires formalizing implicit institutional knowledge into explicit rules, which theoretically highlights potential conflicts in jurisdictional authority. Resolving these requires policy adjustments rather than just software engineering. Another technical challenge is IT Maturity: ensuring that the command center dashboard has an execution server (process engine) ready to handle surges in API synchronization requests during the critical moments of a megathrust event is not something that can be resolved solely by a BPMN document.

To bridge this gap, Figure 7 projects a macro integration architecture where the conceptual BPMN XML file is positioned as a foundational blueprint between static policies and future Command Center dashboard implementations.

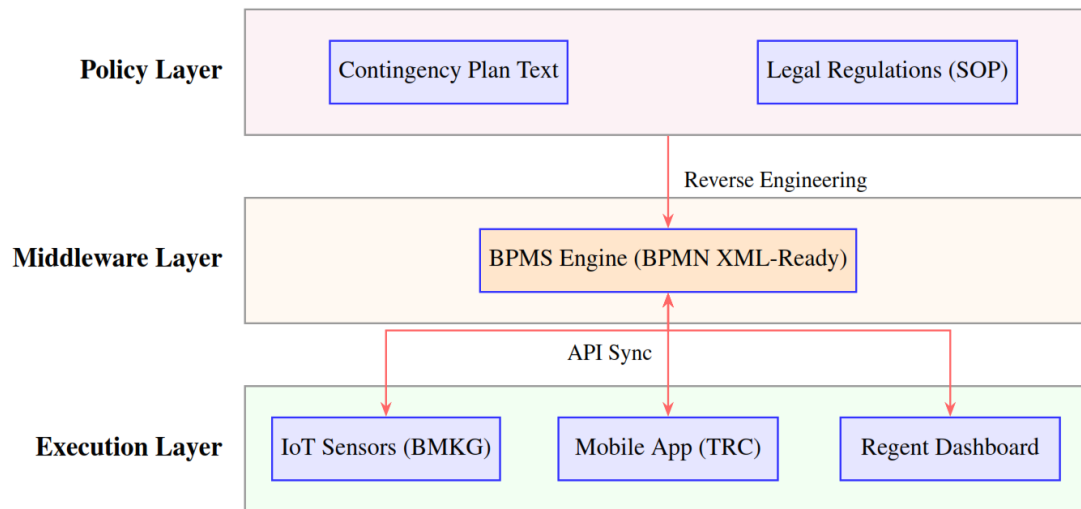


Figure 7. Proposed e-Government Integration Architecture for Disaster Management

Therefore, the empirical contribution of this research is more accurately viewed as a bridging logic framework. We demonstrate that restructuring public plans into formal process representations provides a conceptual mechanism for clarifying organizational boundaries, coordination dependencies, and potential policy ambiguities. However, this is only half the battle toward emergency service-oriented e-Government.

3.4 Discussion

The results show that the transformation of a narrative-based contingency plan to a disaster management workflow expressed in BPMN implies a process of semantic formalization, and not only a document digitalization. Operational activities, accountable actors, conditional rules, and inter-agency coordination were identified through the analysis of the Contingency Plan of Agam Regency, which were then represented by tasks, swimlanes, gateways, message flows, and event elements of BPMN. The traceability matrix creates a direct link between policy phrases and BPMN elements, thus creating a structured bridge between administrative regulations and machine-readable workflow specifications. This result is in line with prior works on emergency process modeling [3], [5], but further extends it by taking the contingency plan as an input at the policy level for systematic workflow engineering.

The transformation also shows that narrative policy provisions are not always sufficiently predictable to be directly represented in a computer manner. Deteriorating situations,

coordination requirements, or reaction conditions may require further semantic interpretation before being mapped to formal business rules. In this study, therefore, some criteria were considered as assumptions by the researcher and not as directly regulated values. This conclusion suggests that the policy-to-workflow transfer is fundamentally interpretive and requires traceability to identify regulatory mandates from modeling assumptions. Hence, BPMN is to be seen as an intermediate formalization layer between the policy papers and future e-Government implementation, but not as a direct substitution of the interpretation of policies.

This results in a BPMN architecture that stresses even more the value of specified organizational boundaries and parallel coordination. Swimlanes clarify the duties of the actors, such as the Regent, BPBD, Pusdalops, Health Agency and Public Works Agency. Meanwhile, Parallel Gateways formally describe tasks that may need to be carried out simultaneously during an emergency reaction. These modeling capabilities nevertheless should not be taken as evidence that BPMN itself solves organizational coordination challenges. Rather, the model elucidates the duties, dependencies and coordination needs, and establishes a framework for the later system implementation and organizational assessment.

The findings of the validation give preliminary support for the quality of the proposed artifact. The correctness, completeness, consistency, usefulness and application were examined by three independent experts, who awarded ratings ranging from 4.33 to 4.67 on a five-point scale. Technical checking with Camunda Modeler 5.20.0 showed no BPMN syntax issues and XML validation showed that the item was well constructed. Results show that the artifact is consistent in structure and regarded relevant by the participating experts. But syntactic compliance with ISO/IEC 19510 does not imply that it will execute. A BPMN model could be compliant to the notation but would nonetheless suffer runtime issues when deployed into a process engine especially when emergency situations change from the preset process assumptions. The `isExecutable="true"` setting in the BPMN XML should therefore be interpreted as an executable process definition on the modeling level, and not as an indicator that the process has already been deployed or is running in a process engine.

The debate also points to the particular needs of emergency workflows. Disaster response differs from normal administrative processes in that there may be no communication infrastructure, inadequate information, changing priorities and judgments that require human discretion. As such, future implementations should provide fallback communication routes, offline operation, exception paths, escalation mechanisms, timer events and human override possibilities. "Expert comment on fallback communication reinforces this requirement. These mechanisms show that the right goal is not to abolish human judgment, but rather to draw clear lines between system-supported tasks and decision-making under human control.

Finally, the transformation process reveals potential governance consequences. A formalization of roles and decision rules in organizations can improve clarity of authority, information sharing and interagency dependency. However, the possible data silos, political resistance, and jurisdictional disputes found in this study should be viewed as predicted governance concerns, not empirical findings, because they were not assessed through interviews, field observation, or disaster-response drills. The proposed architecture is therefore a conceptual bridge between contingency plans and the future deployment of e-Government workflows. Its contribution is to theoretically show how narrative disaster-management provisions might be converted into a traceable machine-readable BPMN product. Additional process engine execution testing, stakeholder validation, load testing, simulation and field drill validation must be done before the artifact can be considered operationally deployable.

4. CONCLUSION

The high reliance on static, narrative policy documents frequently impedes the flow of coordination in disaster management. Utilizing a Design Science Research (DSR) approach, this study sought to bridge the semantic gap between bureaucratic prose and process modeling. Regarding document abstraction (RQ1), we demonstrated conceptually that ambivalent instructions from the Agam Regency Contingency Plan can be systematically reduced into operational logic through activity mapping, actor authorization, and conditional decision rules. Regarding asynchronous architecture (RQ2), the BPMN modeling illustrated that Parallel Gateways and strict swimlanes provide a mechanism to represent simultaneous cross-agency synchronization. Finally, concerning computational

validation (RQ3), this study highlighted that while syntactic validity is achievable, potential implementation challenges include structural governance issues, such as data silos and the complexity of formalizing discretionary authority into rigid business rules. A key theoretical implication of this study relates to the integration of Process-Aware Information Systems (PAIS) in public administration: public sector SOP documents should be drafted with eventual digitization in mind, serving as conceptual prototypes for digital government infrastructure rather than solely as archival instruments. Furthermore, while this study focuses on Agam Regency, the region's complex coastal and mountainous geography paired with its decentralized cross-agency jurisdiction makes it a highly representative prototype for disaster governance. Therefore, the methodological framework of transforming narrative contingency plans into executable-ready BPMN models may provide a transferable methodological reference for similar inter-organizational contexts, subject to validation in other settings. Limitations and Future Work. Despite achieving structural validity and positive expert validation, we acknowledge that our evaluation relies on ISO/IEC 19510 [21] syntactic conformance and panel reviews rather than empirical deployment data. This limitation means the resulting workflow model serves as a conceptual blueprint rather than a fully field-tested system. Furthermore, this research is limited to a single case study utilizing a single contingency document, without field drill validation. Consequently, the proposed workflow currently exists at the design-maturity phase. Future studies are recommended to expand from conceptual validation to empirical execution testing on process engines such as Camunda[20] or Flowable. Additionally, further research is needed to explore the governance dynamics and policy adjustments required when integrating automated workflow systems into complex inter-organizational structures.

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DECLARATION OF GENERATIVE AI

During the preparation of this work, the authors used generative AI technologies (e.g., AI-assisted language models) solely to improve the readability, language, and academic tone of the manuscript. After using these tools, the authors thoroughly reviewed, edited, and validated the generated text. The authors assume full responsibility and accountability for the final content, findings, and conclusions presented in this publication. Generative AI was not used for data analysis, drawing scientific conclusions, or creating primary figures.

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