Multi-Perspective Review of Intelligence Analysis Models: Postprint

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Abstract

[Purpose/Significance] This paper provides a critical review of research achievements on intelligence analysis models both domestically and internationally, systematically examines the characteristics and advantages of different types of models, aims to elucidate the essence of intelligence analysis models, and provides references for subsequent intelligence analysis research. [Method/Process] Based on different emphases of the models, they are categorized into process-based intelligence analysis models, structure-based intelligence analysis models, and comprehensive intelligence analysis models, each being reviewed separately. [Results/Conclusion] The analysis reveals that process-based intelligence analysis models primarily summarize the procedural characteristics of intelligence analysis from different perspectives including the intelligence cycle, task resolution process, and cognitive process; structure-based intelligence analysis models focus on elements such as tasks, data, and methodological techniques; comprehensive intelligence analysis models emphasize the application of engineering thinking and integration thinking.

Full Text

Preamble

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Abstract

[**Purpose/Significance**] This paper reviews research on intelligence analysis models both domestically and internationally, examining the characteristics and strengths of different model types to elucidate the essential nature of intelligence analysis models and provide reference for future research. [**Method/Process**] Based on differing model emphases, we categorize models into process-based intelligence analysis models, structure-based intelligence analysis models, and comprehensive intelligence analysis models, reviewing each category respectively. [**Result/Conclusion**] The analysis reveals that process-based models primarily summarize the procedural characteristics of intelligence analysis from perspectives of the intelligence cycle, task-solving processes, and cognitive processes; structure-based models focus on elements such as tasks, data, and methodological techniques; and comprehensive models emphasize the application of engineering thinking and integration thinking.

Keywords: Intelligence Analysis; Intelligence Analysis Model; Intelligence Task; Multi-source Data; Intelligence Analysis Method
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Introduction

In the era of big data and artificial intelligence, the integration of analytical concepts and intelligent technologies is transforming intelligence analysis paradigms. Intelligence tasks have become more context-specific and goal-oriented, data sources more multi-sourced and complex, and demands for methodological integration and innovation more pronounced—all collectively influencing the evolution of intelligence analysis concepts. Past research from single perspectives is no longer sufficient to reveal the essence of intelligence analysis; multi-dimensional perspectives are needed for re-examination. In the field of intelligence analysis, modeling methods have gradually become important scientific research approaches. Scholars have extensively studied the construction of intelligence analysis models from various perspectives, producing rich research outcomes. This paper focuses on systematically reviewing these domestic and international research results, aiming to clarify the essence of intelligence analysis models, identify characteristics and advantages of different model types, and provide reference for subsequent intelligence analysis research.

Before proceeding with the review, we must first define intelligence analysis models. This paper defines intelligence analysis (also called information analysis or intelligence research) as a scientific research process that identifies specific tasks based on societal needs, extensively collects relevant data and materials, conducts targeted field investigations, and applies scientific research methods to organize, refine, and scientifically screen data, resources, and related information to derive regular conclusions or predictive decisions. Based on this definition, an intelligence analysis model is a conceptual representation that describes and abstracts this process.

A subsequent question concerns model origins—how to design models. Models can generally be divided into physical models and conceptual models: physical models are tangible representations of things (e.g., a world map as a physical model of Earth), while conceptual models are products of thought that systematically describe things through abstract terms. Conceptual models are developed through two primary pathways: (1) models derived from actual data, such as various statistical models; and (2) models created based on extensive scientific knowledge, such as the Hall three-dimensional model. Clearly, intelligence analysis models are conceptual models based on knowledge from the intelligence analysis field. R.M. Clark suggests that intelligence analysis models can be structural, functional, process-oriented, or any combination thereof. Luo Jinzeng summarizes three main model types in intelligence studies: behavioral models, structural models, and mathematical models. Building on these perspectives and according to differing model emphases, this paper reviews intelligence analysis models from three perspectives: process-based, structure-based, and comprehensive. This classification perspective draws from systems theory's definition of "system" as "an organic whole composed of certain elements interconnected in specific structural forms with certain functions." This paper views intelligence analysis as a system possessing characteristics of "elements," "structure," and "function."

2. Research Methods

2.1 Review Approach

Process models describe system movement, behavior, and function, reflecting system dynamics. They summarize model types from the perspective of exhibiting system behavior, working steps, and business processes, emphasizing dynamic and functional aspects. Process models typically use text-labeled boxes to represent system elements, with arrows connecting boxes to indicate step sequences or functional transitions. Intelligence workflow models and decision process models are feedback-based process models requiring output-adjusted inputs, where previous outputs affect subsequent steps. Traditionally, intelligence analysis follows sequential steps including requirement definition, collection, processing, analysis, and evaluation, demonstrating procedural characteristics. The procedures and steps researchers adopt constitute business processes, which vary across industries and fields—some based on the intelligence cycle, others on business processes, and some reflecting researchers' thinking procedures—thus forming various process-based intelligence analysis models.

Structure-based models focus on describing the structure of different elements in intelligence analysis and clarifying relationships between elements. They can be subdivided into four types: (1) Set models, which use intersecting closed graphics to represent set elements and relationships, clearly describing relationships through inclusion, overlap, combination, and complementation, embodying set theory; (2) Hierarchy models, which manifest as simple hierarchical structures for describing main problem-solving factors and their relationships, commonly represented as pyramids or tree diagrams; (3) Matrix models, which optimize hierarchy models by describing relationships between two hierarchical systems, providing decision-makers with comparative bases for multiple pathway choices; and (4) Network models, which extend matrix models using graph theory methods with points and lines, where points represent elements and lines represent relationships, expressing multi-dimensional relationships across multiple hierarchical systems.

Comprehensive models combine process and structure models, including formal integration of process and structure models and integration of various intelligence analysis elements, viewing intelligence analysis from the perspective of relationships among elements, structure, and function.

2.2 Literature Selection

Given the broad domains and diverse tasks involved in intelligence analysis research, this review synthesizes multiple data sources including academic papers, monographs, scientific and technical intelligence reports, industry reports, and think tank research outputs. During literature selection, themes included but were not limited to models related to "intelligence analysis," "intelligence research," "competitive intelligence," "scientific and technical intelligence," "intelligence process," and "intelligence service." English search terms included "information analysis," "intelligence study," "competitive intelligence," "intelligence service," "science and technology intelligence," etc., aiming to comprehensively identify literature closely related to intelligence analysis practice.

3. Multi-Perspective Intelligence Analysis Models

3.1 Process-Based Intelligence Analysis Models

3.1.1 Intelligence Cycle-Based Models Intelligence cycle-based models originated in the U.S. military post-WWII. Traditional military intelligence analysis has long followed a series of steps that L.K. Johnson termed the "intelligence cycle," divided into five stages: planning and direction, collection, processing, analysis and production, and dissemination. In 2000, the U.S. military issued the *Doctrine for Intelligence Support to Joint Operations*, expanding the intelligence cycle into six stages: planning and direction, collection, processing, analysis and production, dissemination and integration, and evaluation [Figure 1: see original paper].

Intelligence cycle-based models typically begin with requirement determination, followed by planning and direction. During collection, researchers gather necessary intelligence, then process information. In the analysis stage, newly collected and processed materials are combined with historical data to produce intelligence products for distribution to users while maintaining communication and integrating feedback. Finally, activities across all intelligence cycle stages are evaluated to determine whether to transition to a new requirement phase and begin a new cycle.

U.S. competitive intelligence expert J.P. Herring proposed the KIT (Key Intelligence Topics) concept in 1999, constructing a model for the entire competitive intelligence workflow known as the Herring Model [Figure 2: see original paper]. Starting from user requirements, this model comprises five steps: planning and direction, collection, processing and storage, analysis and production, and dissemination, forming a competitive intelligence cycle model reflecting the intelligence cycle. The Herring Model's advantages include: (1) emphasizing requirement analysis through KITs to identify core competitive intelligence needs, providing an effective requirement analysis mechanism; and (2) stressing the importance of participants, recognizing that both users (decision-makers) and analysts' cognition affects intelligence efficiency and product quality, necessitating clear understanding of participants' true needs.

J.E. Prescott and R. Williams adapted the Herring Model to propose the User-driven Competitive Intelligence Model [Figure 3: see original paper], emphasizing trust relationships between analysts and decision-makers. This model highlights interactive processes between participants, examining their positions and functions from a "human element" perspective. The trust mechanism ensures integration between competitive intelligence processes and organizational decision-making.

However, intelligence cycle-based models have limitations. K. Sherman argues they ignore stakeholder networks in intelligence analysis, as most analysis is actually non-linear. Consequently, scholars began exploring non-linear, networked models. In 2004, the U.S. military replaced "intelligence cycle" with "intelligence process" in *Joint and National Intelligence Support to Military Operations*, constructing a six-action intelligence process model using network topology rather than linear structure [Figure 4: see original paper], demonstrating interactivity and diversity. However, this model still follows conventional cycle stages and lacks practical guidance.

3.1.2 Task-Oriented Process Models To address traditional cycle model limitations, intelligence analysis shifted toward demand- and task-centered approaches. R.M. Clark's "target-centric" model (2006) exemplifies this trend [Figure 5: see original paper]. Task definition is the first step, making user requirements explicit. The model includes target identification, information requirement clarification, source collection, new information acquisition, and user requirement updating steps. This network process allows all participants to find their positions and functions, changing traditional linear patterns. Its advantages include clear analytical targets, effective resource integration, and participant interaction. Critically, Clark views the target as a dynamic, evolving network structure integrating subsystems, combining task, participants, process, and function considerations.

Chinese scholars have constructed domain-specific models. Guo Chunxia et al. built an emergency decision-making intelligence architecture for sudden incidents, subdividing tasks into disaster trend analysis, negative public opinion monitoring, risk assessment, monitoring and early warning, and comprehensive judgment, integrating IoT, internet, and sensor data with methods like association analysis, semantic reasoning, sentiment analysis, and visualization. Xu Xukan et al. constructed a sudden incident intelligence analysis model from organizational, business, and information process perspectives [Figure 6: see original paper], featuring a classification and triage module creating four incident knowledge bases.

3.1.3 Cognition-Based Process Models Cognitive process models emphasize how analysts' and users' cognition affects efficiency and quality. Foreign scholars developed intelligence cognition theories, while Chinese scholars proposed metacognition concepts and modeled thinking processes.

Xu Fang et al. constructed a cognitive psychology-based model abstracting intelligence analysis into four components: social factors, analysis process, cognitive process, and cognitive system, emphasizing analysts' reasoning and thinking. Tang Shanhong proposed a defense technology intelligence research thinking process model [Figure 7: see original paper], externalizing implicit thinking activities into six stages: problem discovery, intelligence conceptualization, hypothesis generation, material 预判, analysis and synthesis, and solution formation, providing a comprehensive path from problem to solution.

Overall, process models have formed relatively standardized paradigms incorporating steps like requirement analysis, planning, collection, processing, analysis, dissemination, and evaluation. Cycle-based models follow continuous, ordered, linear processes forming feedback chains but ignore non-linear cognitive processes. Task-oriented models address these limitations, while cognition-based models emphasize analysts' cognitive processes from a participant perspective.

3.2 Structure-Based Intelligence Analysis Models

3.2.1 Task-Content-Oriented Models While process models describe task-solving procedures, they lack task content elaboration. Scholars have built task-content-oriented models examining hierarchical relationships among subtasks.

RAND Corporation's Glenn Kent proposed the "strategy-to-tasks" model in the mid-1990s, decomposing abstract problems into executable subtasks through hierarchical functional analysis. For example, national economic conditions can be broken down into macroeconomic stability, infrastructure environment, financial stability, and economic health, with each major task further decomposable. This hierarchy model identifies Key Intelligence Questions (KIQs) to prioritize core tasks, applicable to national policy and economic analysis.

Zou Yimin et al. proposed an object behavior-based attention model for technology monitoring [Figure 8: see original paper], structuring domain prior knowledge and requirements into machine-readable triples for dynamic network information identification. This network model semantically associates three key elements (domain behavior patterns, institutional behavior patterns, and behavior dictionaries), representing multi-object, multi-dimensional relationships.

In competitive intelligence, Han Chunhua et al. proposed a knowledge integration-based model [Figure 9: see original paper] examining coupling relationships between competitive intelligence analysis and knowledge integration across three dimensions: subject, knowledge object, and time.

3.2.2 Multi-Source Data-Oriented Models Modern intelligence analysis incorporates diverse sources beyond traditional literature, including network data, social media, and government open data. He Defang (2009) proposed a "factual data + tools/methods + expert wisdom" methodology emphasizing factual data like research outputs, patents, R&D investment, and case studies. Li Guangjian et al. argued for full-resource analysis to reveal multi-faceted facts.

Qu Zhikai et al. constructed a big data-based sudden incident intelligence analysis model integrating e-government, media, social network, and IoT data, emphasizing conversion and fusion of unstructured and heterogeneous data [Figure 6: see original paper]. These models highlight multi-source data's central role and promote methodological innovation.

3.2.3 Method-Oriented Models Method-oriented models examine method applicability to tasks. Bao Changhuo et al. proposed the CMT (Capital, Market, Time) three-dimensional analysis model [Figure 10: see original paper], analyzing competitors' states across market, capability, and time dimensions. Qian Jun constructed a five-level hierarchy model [Figure 11: see original paper] categorizing 37 competitive intelligence methods across macro-environment, industrial structure, organizational operation, inter-organizational comparison, and organizational resource analysis tasks, providing finer-grained method selection guidance than traditional frameworks.

However, existing method-oriented models remain broad and lack detailed, targeted mappings between methods and data, limiting practicality.

3.3 Comprehensive Intelligence Analysis Models

3.3.1 Engineering Thinking-Based Models Engineering thinking involves systematizing experience, skills, and knowledge to create reproducible value. The Institute of Scientific and Technical Information of China proposed the "factual data + tools/methods + expert wisdom" methodology in 2009, integrating engineering and systematic thinking into intelligence research. He Defang defined intelligence engineering as applying intelligence science principles creatively to design and develop elements (data, methods, technologies), workflows, and organizational management for automation, standardization, and systematization.

The Guangdong Science and Technology Library implemented this concept [Figure 12: see original paper], constructing a model integrating data, methods, and expert wisdom as core elements. Tang Xiaobo et al. extended this research using Hall's three-dimensional structure, building a theoretical model including time dimension (planning, collection, service, evaluation), logic dimension (problem clarification, target setting, scheme design, synthesis, analysis, implementation), and knowledge dimension (intelligence science theory, methods, technology, expert wisdom) [Figure 13: see original paper]. This three-dimensional structure integrates process, elements, and thinking procedures through activity matrices mapping relationships between dimensions.

3.3.2 Integration Thinking-Based Models Multi-source data offers greater dimensionality and breadth than single sources, enabling multi-perspective observation and understanding. Wu Chensheng et al. proposed the "Intelligence 3.0" concept for internet+ and big data environments, identifying four characteristics: holographic data sources, integrated methods, intelligent production, and inclusive services. They constructed a distributed, structured, diversified, hierarchical collaborative service model [Figure 14: see original paper].

Zhang Jianian et al. compared intelligence analysis and big data analysis processes, proposing a fusion model [Figure 15: see original paper] with three pathways: (1) traditional intelligence analysis starting from requirements, (2) direct intelligence analysis through big data analysis, and (3) integrated analysis combining specific task-based "small data" analysis with domain big data mining. This model inherits engineering thinking, proposing fusion mechanisms through conceptual, process, technical-rational/human-value, and tool-expert wisdom integration.

4. Summary and Discussion

Intelligence analysis model research holds rich theoretical and practical value with broad research directions. This review yields several conclusions:

4.1 Intelligence analysis models primarily take three forms: process models, structure models, and comprehensive models. Since intelligence analysis possesses both elemental and procedural characteristics, practical model construction typically requires combining multiple forms.

4.2 Process-based models have relatively standardized paradigms, typically incorporating linear or networked flows of requirement analysis, planning, collection, processing, analysis, dissemination, and evaluation. Intelligence cycle-based models follow continuous, ordered, linear processes but ignore analysts' non-linear cognitive processes. Task-oriented models address these limitations, while cognition-based models emphasize cognitive processes from participant perspectives. Process models effectively depict steps and workflows but inadequately elaborate on specific task and data content.

4.3 Structure-based models focus on tasks, data, methods, and technologies. Task-content-oriented models enhance operability by hierarchically decomposing tasks into executable subtasks but lack multi-dimensional task mapping. Multi-source data-oriented models adapt to big data contexts but need systematic data source organization. Method-oriented models provide task guidance but remain broad, lacking fine-grained method-data mapping and practical applicability.

4.4 Comprehensive models emphasize engineering and integration thinking. Engineering thinking aims for automation and systematization, while integration thinking synthesizes multi-source knowledge to enrich analysis content, hierarchy, and confidence. The two approaches are complementary: engineering enables better integration, while integration requires engineering implementation. However, comprehensive models inadequately integrate tasks, methods, and data, with insufficient research on selection relationships and matching mechanisms.

This multi-perspective review clarifies intelligence analysis models' connotations and extensions, enriching research content and providing beneficial references for future studies.

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Review on the Research of Information Analysis Models Under Multiple Perspectives

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Abstract: [Purpose/significance] This paper focuses on the research results of information analysis models at home and abroad, combing the characteristics and advantages of different types of models, aiming at dialysis of the nature of information analysis models, in order to provide reference for future information analysis research. [Method/process] According to the different emphases of the models, this paper reviewed the process-based information analysis models, structure-based information analysis models and comprehensive information analysis models. [Result/conclusion] It is found that the process-based information analysis models summarized the procedural characteristics of information analysis from different aspects of intelligence cycle, task-solving process and cognitive process; the structure-based information analysis models focused on elements such as tasks, data, methods and technologies; and the comprehensive information analysis models focused on the application of engineering thinking and fusion thinking.

Keywords: information analysis; information analysis model; intelligence task; multi-source data; information analysis method

Note: Figure translations are in progress. See original paper for figures.