REVIEWER'S REPORT

Dissertation: Patent analysis methodology for validating and developing the Trends of Engineering Systems Evolution

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Reviewer: Dr. Sergei Logvinov, TRIZ Master, Chairman of TRIZ Research and Development Council

Preliminary remarks

I consider it necessary to begin with transparency regarding my role in the history of this work.

At the pre-defense in Malaysia in 2024, I provided a critical assessment of the initial version of the dissertation. My main observation was that the work relied predominantly on market data, whereas verification of the Trends of Engineering Systems Evolution (TESE) requires a patent foundation. I directly indicated to the authors that they needed to take technical systems that had passed through all five stages of the S-curve and analyze their development based on patents.

Moreover, together with Yury Fedosov, I studied the materials and concluded that the patent search methodology developed by the authors represents independent value. The authors were advised to focus on more detailed development and description of the methodology they employed.

This history makes my review not a neutral observation, but an assessment of results that the authors achieved, in part, due to my criticism. The audience is entitled to take this circumstance into account.

Problem statement

The problem addressed by the dissertation is formulated correctly.

Altshuller built TRIZ on patent analysis. This is the empirical foundation of the theory. However, the methodology of this analysis was never formalized or transferred. The result is a fifty-year gap between the theoretical apparatus of TRIZ and the possibility of its systematic verification on patent material.

Modern patent databases are incompatible with the conceptual apparatus of TRIZ for several reasons:

- Classification systems (IPC) fragment functionally related inventions.

- The Main Parameter of Value as a TRIZ concept has no direct correspondence in patent terminology.

- Terminology evolves, and modern search queries fail to find early patents.

The authors accurately identified these problems. Formulations are clear, terminology is correct.

Analysis of the proposed methodology

Methodology structure

The six-stage structure is logical and complete:

1. Selection of technical system and identification of main function.

2. Determination of MPV and historical-technical review.

3. Periodization by S-curve stages.

4. Formation of basic vocabularies.

5. Primary analysis with refinement (iterative cycle).

6. Extended search.

Each stage has defined inputs and outputs. Procedures are described with sufficient detail for independent reproduction. This is not a declarative description, but an instrumental methodology.

Functional approach

The central solution – building the search from the invariant main function instead of relying on classification – is methodologically sound.

The main function of a technical system does not change when the technical implementation changes. Classification is tied to implementation and therefore fragments the system's history. The authors correctly identified this distinction and built their search strategy upon it.

This is an application of the fundamental principle of functional analysis to a new domain. The solution is neither trivial nor obvious.

MPV decomposition

The mechanism for transforming the Main Parameter of Value into patent terminology deserves separate analysis.

MPV is a market-level characteristic. It does not appear directly in patents. The authors propose systematic decomposition: MPV → physical parameters (through formulas or cause-and-effect chains) → patent description terminology.

This creates a reproducible bridge between the language of TRIZ and the language of patents. The procedure is formalized and can be applied by an independent researcher.

Stage-specific vocabularies

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Adaptation of terminology to historical periods is a practically important solution.

Patents from the 19th century use different vocabulary than 21st-century patents for the same technology. Without accounting for terminological evolution, early stages systematically fall out of the search.

The authors solve this problem through the formation of stage-specific vocabularies based on S-curve characteristics. The approach is systematic and reproducible.

Iterative refinement

The methodology does not claim the possibility of constructing an ideal query a priori. Instead, it proposes a cycle: query → results → analysis of actual terminology → vocabulary refinement → repeat query.

This is a methodologically mature approach. Patents themselves become a source of terminology for their own search. The process is self-correcting.

Validation assessment

Validation was conducted on sufficient empirical material.

The main case – facsimile communication – covers the complete life cycle: 177 years, five S-curve stages, more than 16,000 patents. This is exactly the type of analysis I demanded in Malaysia.

Results are quantitatively measured:

- Precision: 85% versus 58% with classification-based search.

- Coverage of early stages: 90% versus 20%.

Extended validation on additional technical systems confirms the robustness of results.

The use of the professional PatSnap platform ensured data quality. This is a serious approach requiring substantial resources.

Methodological innovations

The work goes beyond creating a search tool. Patterns of independent significance have been identified:

Classification fragmentation as an indicator. In the early stages of technical system development, patents are scattered across unrelated classes – a dedicated category does not yet exist. This can serve as an indicator of an early stage.

Invariance of stage characteristics. Vocabularies of S-curve stage characteristics are applicable to various technical systems. This opens the path to generalized vocabularies that accelerate methodology application.

Geographical migration of technologies. During the decline stage, technologies migrate to developing economies with simultaneous simplification of design. Patent activity does not cease but shifts geographically and technologically.

The last discovery belongs to Dr. Lin and is based on analysis of Chinese patents. This demonstrates the value of international collaboration.

Terminological correctness

I separately note the quality of terminological work.

The authors consistently distinguish:

- Patent search (for TRIZ research purposes) and patent research (per GOST standard).

- Main function of the system and functions of subsystems.

- MPV as a market characteristic and technical parameters in patents.

- Search precision and coverage.

Definitions are given explicitly. Terms are used consistently. This increases reproducibility and facilitates communication with researchers outside the TRIZ community.

Comments

Periodization

Establishing boundaries between S-curve stages relies on expert judgment. Stage indicators are described, but the procedure for their application allows for variability. Different researchers may establish somewhat different boundaries for the same system.

This is not a critical deficiency – any periodization contains an element of expert assessment. However, development of more formalized criteria would increase reproducibility.

Resource intensity

A complete analysis cycle requires significant time investment. For widespread application of the methodology, partial automation is necessary, especially for vocabulary formation and iterative refinement.

Generalized vocabularies

Invariant vocabularies of stage characteristics are a promising tool but are presented in initial form. Their expansion through analysis of additional systems is a task for continued research.

These comments indicate directions for development, not defects in the work.

Positioning in the TRIZ tool system

The authors correctly position the methodology relative to existing tools.

The methodology does not replace patent analysis tools (GoldFire and analogues) but complements them. GoldFire is effective for deep analysis of found patents. The proposed methodology solves the preceding task – how to find relevant patents for analysis.

The methodology is not patent research in the sense of GOST R 15.011-2024. It does not solve problems of patentability or patent clearance. It is a tool for TRIZ research – forming an empirical base for TESE verification.

Such positioning is accurate and helps avoid methodological confusion.

Work trajectory

The path of this dissertation is atypical and deserves attention.

The initial version received criticism for insufficient description of the applied methodology for patent information search and analysis. The authors did not reject the criticism and did not attempt to defend the original approach. They fundamentally reworked the work.

In the process of reworking, they discovered that the patent search methodology, created as an auxiliary tool, represents independent value. The focus shifted. This allowed preserving the valuable core of the work.

Such a trajectory – from harsh criticism through reconsideration to a strengthened result – requires researchers to have the ability to hear feedback, willingness to change direction, and scientific honesty. The authors demonstrated these qualities.

Significance for TRIZ

The work creates the first systematic patent search methodology adapted to the conceptual apparatus of TRIZ.

This fills a gap that existed for fifty years. Now the TRIZ community has a tool for forming representative patent samples by S-curve stages. Systematic verification and development of LTSE on patent material becomes possible.

As Chairman of the TRIZ Research and Development Council, I consider this work a contribution to the research infrastructure of the theory.

Conclusion

The Dr Yatsunenko and Dr Lin dissertation solves a real methodological problem of TRIZ.

The methodology is substantiated, formalized, and validated. Terminology is correct. Procedures are reproducible. Results are measurable.

The identified directions for development represent natural evolution of the methodology.

The work meets the requirements for awarding TRIZ Master Level 5 qualification in scope, rigor, originality, and practical significance.

I recommend the dissertation for defense and award of TRIZ Master Level 5 qualification to the authors.

Dr. Sergei Logvinov

TRIZ Master

Chairman of TRIZ Research and Development Council

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