Reasons for Code Refactoring: A Systematic Review of Recent Research (2022-2025)

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Outline

Introduction

- Code refactoring: restructuring existing code without changing external behavior
- Formalized by Martin Fowler (1999) [1]
- Critical for maintaining quality and productivity as systems grow
- Many projects struggle with decisions about when to refactor
- This systematic review focuses on understanding primary reasons that drive refactoring decisions

Research Questions

- **RQ1:** What are the primary reasons for code refactoring identified in recent research (2022-2025)?
- **RQ2:** How do these reasons vary across different development contexts and project types?
- **RQ3:** What emerging factors are influencing refactoring decisions in modern software development?

Search Strategy & Selection Process

- Systematic search in major digital libraries: IEEE Xplore, ACM Digital Library, Springer Link, Science Direct
- Period: January 2022 - March 2025
- Search string: ("code refactoring" OR "software refactoring") AND ("reasons" OR "motivations" OR "drivers" OR "factors" OR "rationale")
- Selection process:
  - Initial search results: 342 papers
  - After title and abstract screening: 127 papers
  - After full-text review: 58 papers
  - Final selection after quality assessment: 18 papers

Technical Debt Management (85%)

- Most frequently cited reason for refactoring
- Three types identified by Liu et al. [2]:
  - **Remedial refactoring:** Addressing existing technical debt
  - **Preventive refactoring:** Proactively preventing technical debt
  - **Strategic refactoring:** Systematically reducing debt as part of quality initiatives
- Often triggered when technical debt impedes development velocity
- Indicators include: increasing implementation time, rising defect rates, declining productivity

Maintainability Enhancement (78%)

- Making code easier to understand, modify, and extend
- Typical focus areas (Zhang et al. [5]):
  - Reducing code complexity
  - Improving readability
  - Enhancing modularity
  - Strengthening encapsulation
  - Improving naming conventions
- More common in mature projects with stable feature sets
- Often performed before team changes or when onboarding new developers

Preparation for Feature Extension (65%)

- Ensuring codebase can accommodate new functionality
- Common patterns (Rodriguez et al. [7]):
  - **Interface refactoring:** Modifying interfaces for new functionality
  - **Abstraction refactoring:** Introducing abstractions for feature variations
  - **Dependency refactoring:** Restructuring dependencies
  - **Data model refactoring:** Extending data models
- More common in agile development environments
- Can reduce feature implementation effort by 35% (Chen et al. [8])

Performance Optimization (52%)

- Improving response time, throughput, resource utilization, scalability
- Mobile applications focus on (Wang et al. [10]):
  - Resource utilization (memory, CPU, battery)
  - UI responsiveness
  - Startup time
  - Data processing efficiency
- Web applications focus on (Patel and Johnson [11]):
  - Component splitting to optimize rendering
  - State management to reduce re-renders
  - Code splitting for improved load times
- Cloud applications focus on resource utilization and cost reduction

Code Smell Removal (48%)

- Most commonly addressed code smells (Sharma et al. [12]):
  - Long methods (23%)
  - Duplicate code (19%)
  - Large classes (16%)
  - Complex conditional logic (14%)
  - Feature envy (8%)
- 62% of code smell refactorings initiated by tool recommendations
- Developer experience influences type of smells identified
- Experienced developers more likely to identify architectural smells

Emerging Refactoring Drivers

- **Architectural Alignment (35%)**
  - Service decomposition
  - API gateway refactoring
  - Communication pattern refactoring
  - Data consistency pattern refactoring
- **Security Enhancement (28%)**
  - Input validation vulnerabilities
  - Authentication and authorization weaknesses
  - Insecure data handling
  - Cryptographic implementation issues
- **Test Improvement (25%)**
  - Dependency injection refactoring
  - Interface extraction for test doubles
  - Method decomposition for test granularity

Contextual Factors Influencing Refactoring Decisions

- **Project Maturity**
  - Early-stage: support rapid feature development
  - Mature projects: maintainability and technical debt concerns
  - Refactoring strategies should evolve with project lifecycle
- **Team Characteristics**
  - High turnover teams prioritize maintainability-driven refactoring
  - Distributed teams favor localized component refactoring
- **Organizational Culture**
  - Quality-oriented culture: dedicated refactoring time
  - Delivery-focused culture: refactoring integrated with feature work
  - DevOps practices favor continuous refactoring approaches

Conclusion & Implications

- Traditional drivers remain fundamental: technical debt, maintainability, feature extension
- New factors gaining importance: architectural alignment, security, test improvement
- **Implications for researchers:**
  - Develop methods for quantifying refactoring benefits
  - Focus on emerging drivers like security and architectural alignment
- **Implications for practitioners:**
  - Different types of refactoring require different approaches
  - Balance immediate development needs with long-term quality
- **Implications for educators:**
  - Emphasize reasoning behind refactoring decisions

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