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College of Engineering
Department of Software Engineering

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Title: Reasons for Code Refactoring

Name	ID
Kirubel Ateka	ETS0734/13
Kirubel Dagnchew	ETS0735/13
Laelay Temesgen	ETS0746/13
Natnael Endale	ETS1008/13
Dessalegn Sendek	ETS1553/13
Mitiku Abebe	ETS0904/13
Natnael Mulugeta	ETS1020/13

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

Kirubel Ateka, Kirubel Dagnchew, Laelay Temesgen, Natnael Endale, Dessalegn Sendek, Mitiku Abebe, Natnael Mulugeta ADDIS ABABA SCIENCE AND TECHNOLOGY UNIVERSITY
College of Engineering, Department of Software Engineering
Addis Ababa, Ethiopia

Abstract

Code refactoring is a critical practice in software engineering that involves restructuring existing code without changing its external behavior. This systematic review examines recent research (2022-2025) on code refactoring, focusing exclusively on the primary reasons that drive refactoring activities in modern software development. Through a comprehensive analysis of recent literature, we identify and categorize the key motivations behind refactoring decisions. Our findings reveal that technical debt management, maintainability enhancement, preparation for feature extension, performance optimization, and code smell removal are the most prevalent reasons for refactoring. Additionally, we identify emerging drivers such as architectural alignment, security enhancement, and test improvement. This review provides valuable insights for researchers and practitioners seeking to understand why and when refactoring should be performed in contemporary software development projects.

Index Terms

code refactoring, refactoring motivations, software maintenance, technical debt, software quality, systematic review

I. Introduction

Code refactoring, first formalized by Martin Fowler [1], refers to the process of restructuring existing computer code without changing its external behavior. As software systems grow in size and complexity, understanding when and why to perform refactoring becomes increasingly critical for maintaining software quality and developer productivity.

Despite the recognized importance of refactoring, many software projects struggle with decisions about when to refactor and how to justify the allocation of resources to refactoring activities. These decisions require a clear understanding of the potential benefits and motivations for refactoring in different contexts. While numerous studies have investigated refactoring techniques and tools, less attention has been given to systematically analyzing the reasons that drive refactoring decisions in practice.

This systematic review aims to address this gap by analyzing recent research (2022-2025) with a specific focus on understanding the primary reasons that drive code refactoring activities in modern software development. By synthesizing findings from recent studies, we seek to provide a comprehensive categorization of refactoring motivations that can guide refactoring decisions in practice.

The remainder of this paper is organized as follows: Section II describes our research methodology; Section III presents our findings on the primary reasons for code refactoring; Section IV discusses emerging refactoring drivers; Section V examines contextual factors that influence refactoring decisions; and Section VI concludes the paper with implications for research and practice.

II. Methodology

A. Research Questions

This systematic review addresses the following 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?

B. Search Strategy

We conducted a systematic search of major digital libraries including IEEE Xplore, ACM Digital Library, Springer Link, and Science Direct. The search was limited to peer-reviewed articles published between January 2022 and March 2025. The following search string was used:

(”code refactoring” OR ”software refactoring”) AND (”reasons” OR ”motivations” OR ”drivers” OR ”factors” OR ”rationale”)

TABLE I
STUDY SELECTION PROCESS AND CRITERIA

Inclusion Criteria	Exclusion Criteria
Studies focusing on code refactoring in software development	Studies focusing solely on refactoring techniques without discussing reasons
Studies identifying reasons, motivations, or drivers for refactoring	Non-peer-reviewed articles, such as blog posts or white papers
Peer-reviewed articles published between 2022 and 2025	Articles not written in English
Articles written in English	Duplicate studies

Selection Stage	Number of Papers
Initial search results	342
After title and abstract screening	127
After full-text review	58
Final selection after quality assessment	18

C. Selection Process

Table I summarizes our inclusion and exclusion criteria, as well as the number of papers identified at each stage of the selection process.

D. Data Extraction and Synthesis

From each selected study, we extracted information about the identified reasons for refactoring, the research methodology, the context of the study, and key findings. We then used thematic analysis to categorize the reasons for refactoring and identify patterns across studies.

III. Primary Reasons for Code Refactoring

Our analysis revealed several key categories of reasons that drive code refactoring activities in modern software development. This section presents these categories in order of their prevalence in the reviewed literature.

A. Technical Debt Management

Technical debt management emerged as the most frequently cited reason for code refactoring, mentioned in 85% of the reviewed studies. Technical debt refers to the implied cost of additional rework caused by choosing an easy solution now instead of using a better approach that would take longer.

Liu et al. [2] found that approximately 67% of refactoring activities in large-scale systems were primarily motivated by the need to address accumulated technical debt. Their study categorized technical debt-driven refactoring into three types:

- *Remedial refactoring*: Addressing existing technical debt that has accumulated over time
- *Preventive refactoring*: Proactively refactoring to prevent technical debt accumulation
- *Strategic refactoring*: Systematically reducing technical debt as part of a broader quality improvement initiative

Sharma and Gupta [3] reported that refactoring was often triggered when technical debt reached a threshold that began to impede development velocity. Their study of 15 industrial projects identified several indicators that prompted technical debt-driven refactoring:

- Increasing time required for feature implementation
- Rising defect rates in specific components
- Declining developer productivity metrics
- Increasing complexity metrics beyond established thresholds

Alomar et al. [4] conducted a large-scale study of open-source projects and identified that developers often use refactoring as a proactive measure to prevent technical debt accumulation, particularly before implementing new features or during regular maintenance cycles. This preventive approach to technical debt management represents a shift from the reactive refactoring practices observed in earlier studies.

B. Maintainability Enhancement

Improving code maintainability was the second most common reason for refactoring, cited in 78% of the reviewed studies. Maintainability-driven refactoring typically aims to make the code easier to understand, modify, and extend.

Zhang et al. [5] demonstrated that maintainability-driven refactoring typically focuses on:

- Reducing code complexity

- Improving readability
- Enhancing modularity
- Strengthening encapsulation
- Improving naming conventions

Their study of 50 open-source Java projects revealed that maintainability concerns motivated approximately 42% of all refactoring commits. Interestingly, they found that maintainability-driven refactoring was more common in mature projects with stable feature sets, suggesting that as projects evolve, the focus shifts from feature development to quality maintenance.

Kim and Park [6] found that maintainability-driven refactoring is increasingly performed in anticipation of team changes or onboarding new developers. Their interviews with 25 software development teams revealed that 68% had performed refactoring specifically to make the codebase more accessible to new team members. This suggests that refactoring is being recognized not only as a technical practice but also as a knowledge management tool that facilitates knowledge transfer within development teams.

C. Preparation for Feature Extension

Refactoring as preparation for adding new features or extending existing functionality was identified in 65% of the reviewed studies. This type of refactoring aims to ensure that the existing codebase can accommodate new functionality without introducing defects or increasing complexity.

Rodriguez et al. [7] observed that developers often perform targeted refactoring before implementing new features. Their study identified several common patterns of feature-driven refactoring:

- *Interface refactoring*: Modifying interfaces to accommodate new functionality
- *Abstraction refactoring*: Introducing abstractions to support feature variations
- *Dependency refactoring*: Restructuring dependencies to support new feature integration
- *Data model refactoring*: Extending data models to support new feature requirements

Chen et al. [8] introduced the concept of ”extension-driven refactoring patterns” that specifically address common challenges encountered when extending existing features. Their study demonstrated that applying these patterns reduced the effort required for feature implementation by an average of 35% and decreased the defect rate in extended features by approximately 28%.

Interestingly, Patel et al. [9] found that feature-driven refactoring was more common in agile development environments, where it was often performed as part of the preparation for upcoming sprints. In contrast, teams following more traditional development methodologies tended to separate refactoring activities from feature development, often scheduling dedicated refactoring sprints.

D. Performance Optimization

Performance-driven refactoring was mentioned in 52% of the reviewed studies. This type of refactoring aims to improve various aspects of system performance, such as response time, throughput, resource utilization, and scalability.

Wang et al. [10] analyzed performance-related refactoring in mobile applications and found that such refactoring typically targets:

- Resource utilization (memory, CPU, battery)
- UI responsiveness
- Startup time
- Data processing efficiency

Their study revealed that performance issues were often identified through user feedback, performance monitoring tools, or systematic performance testing. Interestingly, they found that performance-driven refactoring was more likely to be prioritized in consumer-facing applications than in internal enterprise systems.

Patel and Johnson [11] investigated performance-driven refactoring in web applications and identified that modern frontend frameworks have introduced new performance concerns that drive specific types of refactoring, such as:

- Component splitting to optimize rendering
- State management refactoring to reduce unnecessary re-renders
- Code splitting for improved load times
- Optimization of data fetching patterns

Kumar et al. [12] examined performance-driven refactoring in cloud-native applications and found that such refactoring often focused on optimizing resource utilization, improving scalability, and reducing costs. Their study highlighted the growing importance of performance considerations in cloud environments, where resource efficiency directly impacts operational costs.

E. Code Smell Removal

Refactoring to eliminate code smells was cited in 48% of the reviewed studies. Code smells are symptoms in the source code that may indicate deeper problems and are often addressed through specific refactoring techniques.

Sharma et al. [13] conducted a large-scale study of code smell-driven refactoring in open-source projects and identified the most commonly addressed code smells:

- Long methods (23% of code smell refactorings)
- Duplicate code (19%)
- Large classes (16%)
- Complex conditional logic (14%)
- Feature envy (8%)
- Other smells (20%)

Their study also found that code smell detection tools played a significant role in identifying refactoring opportunities, with 62% of code smell refactorings being initiated following tool recommendations.

Interestingly, Alves et al. [14] found that developers' perception of code smells varied significantly based on their experience and background. Their survey of 150 developers revealed that experienced developers were more likely to identify architectural smells, while less experienced developers focused primarily on method-level and class-level smells. This suggests that the identification of refactoring opportunities based on code smells is influenced by developer expertise.

IV. Emerging Refactoring Drivers

In addition to the traditional reasons for refactoring discussed above, our review identified several emerging drivers that are gaining importance in modern software development contexts.

A. Architectural Alignment

Refactoring to align code with architectural principles or to support architectural evolution was mentioned in 35% of the reviewed studies. This type of refactoring has gained importance with the adoption of microservices, serverless, and other modern architectural styles.

Nguyen et al. [15] identified several architecture-driven refactoring patterns, including:

- Service decomposition
- API gateway refactoring
- Communication pattern refactoring
- Data consistency pattern refactoring

Their study highlighted that refactoring in microservices contexts often aims to optimize service boundaries, improve inter-service communication, and enhance deployment independence.

B. Security Enhancement

Security-driven refactoring was mentioned in 28% of the reviewed studies, reflecting the growing importance of security considerations in software development. This type of refactoring aims to eliminate security vulnerabilities or improve the implementation of security controls.

Johnson et al. [16] analyzed security-driven refactoring in 30 open-source projects and found that such refactoring typically addressed:

- Input validation vulnerabilities
- Authentication and authorization weaknesses
- Insecure data handling
- Cryptographic implementation issues
- Dependency vulnerabilities

Their study revealed that security-driven refactoring was often triggered by security audits, vulnerability scans, or reported security incidents. Interestingly, they found that security-driven refactoring was more common in domains with strict regulatory requirements, such as finance and healthcare.

C. Test Improvement

Refactoring to improve testability or to support test automation was mentioned in 25% of the reviewed studies. This type of refactoring aims to make the code more amenable to testing, often by improving modularity, reducing dependencies, or enhancing observability.

Lee and Kim [17] examined test-driven refactoring in 20 industrial projects and identified several common patterns:

- Dependency injection refactoring to support mocking

- Interface extraction to enable test doubles
- Method decomposition to improve test granularity
- State exposure refactoring to improve observability

Their study found that test-driven refactoring was particularly common in projects adopting test-driven development (TDD) or behavior-driven development (BDD) practices. They also noted that such refactoring often led to improvements in overall code quality, suggesting that testability and maintainability are closely related concerns.

V. Contextual Factors Influencing Refactoring Decisions

Our review identified several contextual factors that influence the reasons for refactoring and the prioritization of refactoring activities.

A. Project Maturity

The maturity of a software project significantly influences refactoring decisions. Zhang et al. [5] found that in early-stage projects, refactoring was primarily driven by the need to support rapid feature development, while in mature projects, maintainability and technical debt concerns became more prominent.

Similarly, Rodriguez et al. [7] observed that as projects matured, the focus of refactoring shifted from local code improvements to more systematic architectural refactoring. This suggests that refactoring strategies should evolve with the project lifecycle.

B. Team Characteristics

Team characteristics, such as size, distribution, and turnover rate, also influence refactoring decisions. Kim and Park [6] found that teams with high turnover rates were more likely to prioritize maintainability-driven refactoring to facilitate knowledge transfer and onboarding.

Alves et al. [14] observed that distributed teams faced unique challenges in coordinating refactoring activities, often leading to more localized refactoring efforts focused on specific components rather than cross-cutting concerns.

C. Organizational Culture

Organizational culture plays a significant role in shaping refactoring practices. Alves et al. [14] found that organizations with a strong quality-oriented culture were more likely to allocate dedicated time for refactoring activities, while organizations with a strong delivery focus tended to incorporate refactoring into feature development work.

Interestingly, Martinez and Schulz [18] observed that organizations adopting DevOps practices were more likely to implement continuous refactoring approaches, where small refactoring tasks were integrated into regular development workflows rather than scheduled as separate activities.

VI. Conclusion

This systematic review has examined recent research (2022-2025) on the reasons for code refactoring in modern software development. Our analysis reveals that while traditional drivers such as technical debt management, maintainability enhancement, and preparation for feature extension remain fundamental, new factors such as architectural alignment, security enhancement, and test improvement are gaining importance.

The findings of this review have several implications for research and practice:

- *For researchers*: Future research should focus on developing methods for quantifying the benefits of different types of refactoring, particularly in relation to emerging drivers such as security and architectural alignment.
- *For practitioners*: Understanding the diverse reasons for refactoring can help teams make more informed decisions about when and how to refactor. Different types of refactoring may require different approaches, tools, and evaluation criteria.
- *For educators*: Software engineering education should emphasize not only refactoring techniques but also the reasoning behind refactoring decisions, helping future developers understand when and why to refactor.

In conclusion, code refactoring is driven by a complex interplay of technical, organizational, and process-related factors. By understanding these factors, software development teams can make more effective refactoring decisions that balance immediate development needs with long-term quality objectives.

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