Testing In-The-Field

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SOFTWARE FAILS IN THE FIELD

WHY?

Just Bad Testing?

Software in the field (SIF)

Empirical Investigation

- RQ1: Why are faults not detected at testing time?
- RQ2: Which elements of the field are involved in field failures?
- RQ3: What kinds of field failures can be observed?
- RQ4: How many steps are needed to reproduce a field failure?

Empirical Investigation

- RQ1: Why are faults not detected at testing time?
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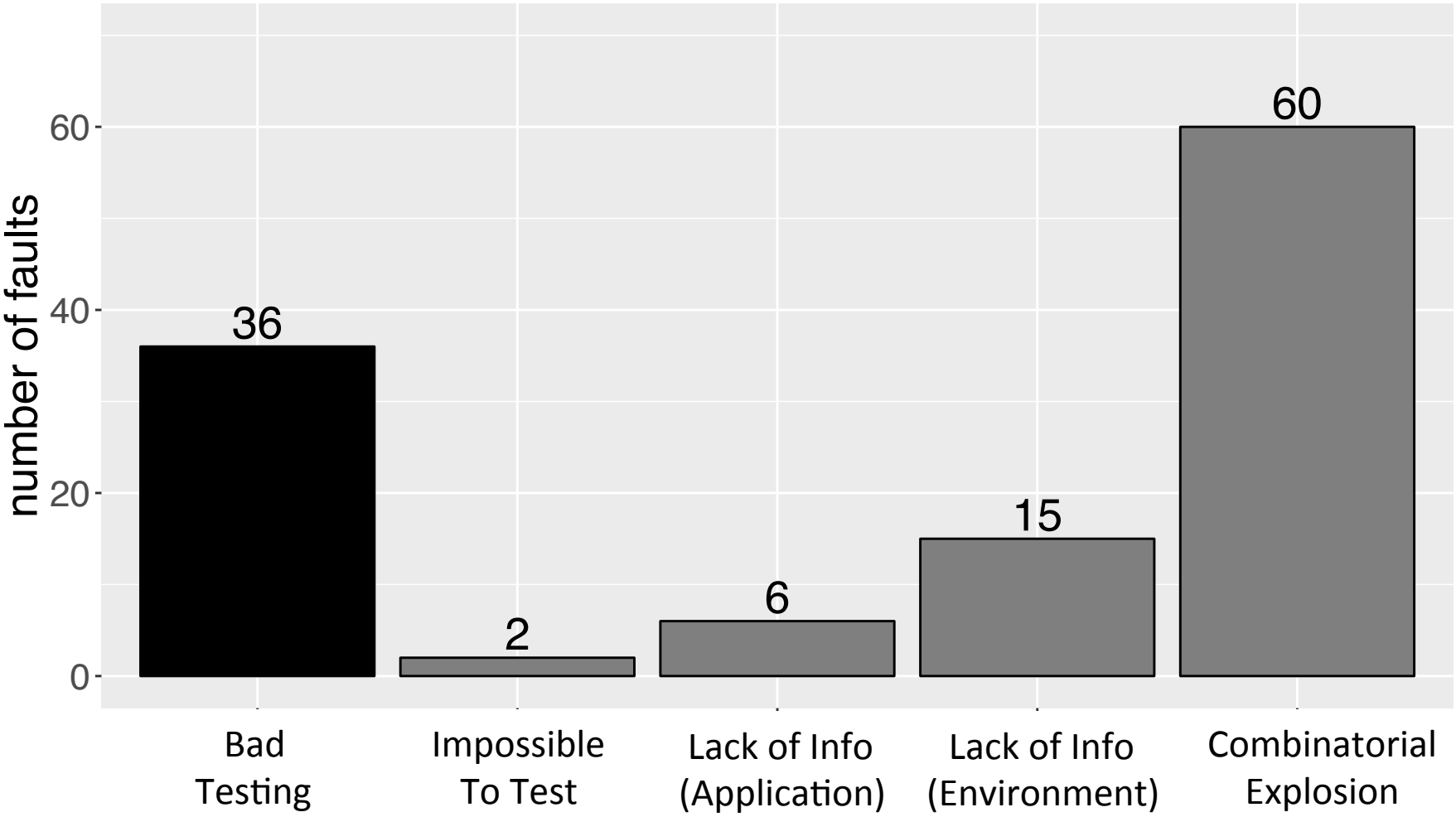
Subjects of the Study

Inspected 412 bug reports: **119 field failures**

RQ1: Why are faults not detected at testing time?

- Bad Testing (BT)
- Impossible To Test (ItT)
- Lack of Information about the Application (LoIA)
- Lack of Information about the Environment (LoIE)
- Combinatorial Explosion (CE)

RQ1: Why are faults not detected at testing time?



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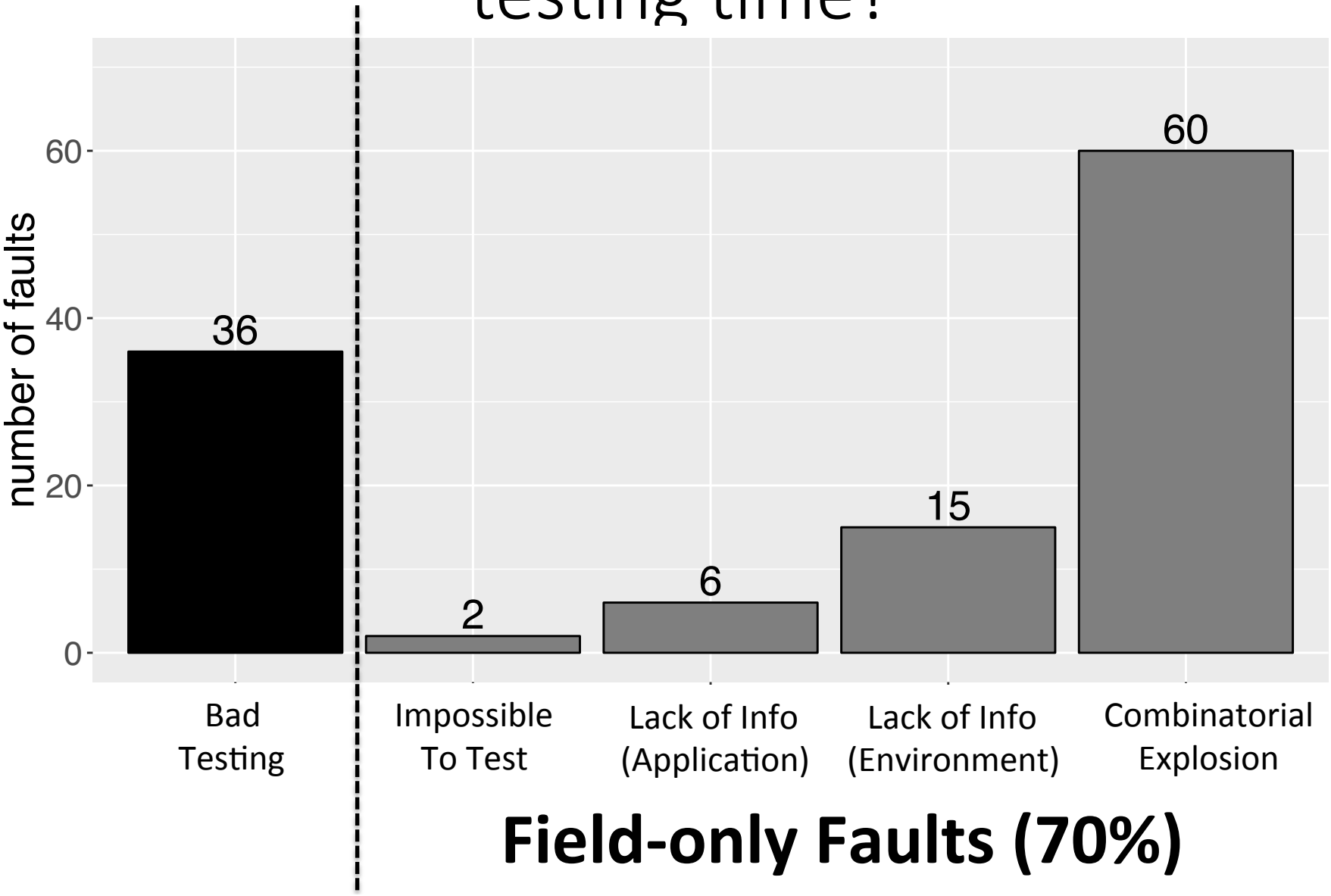
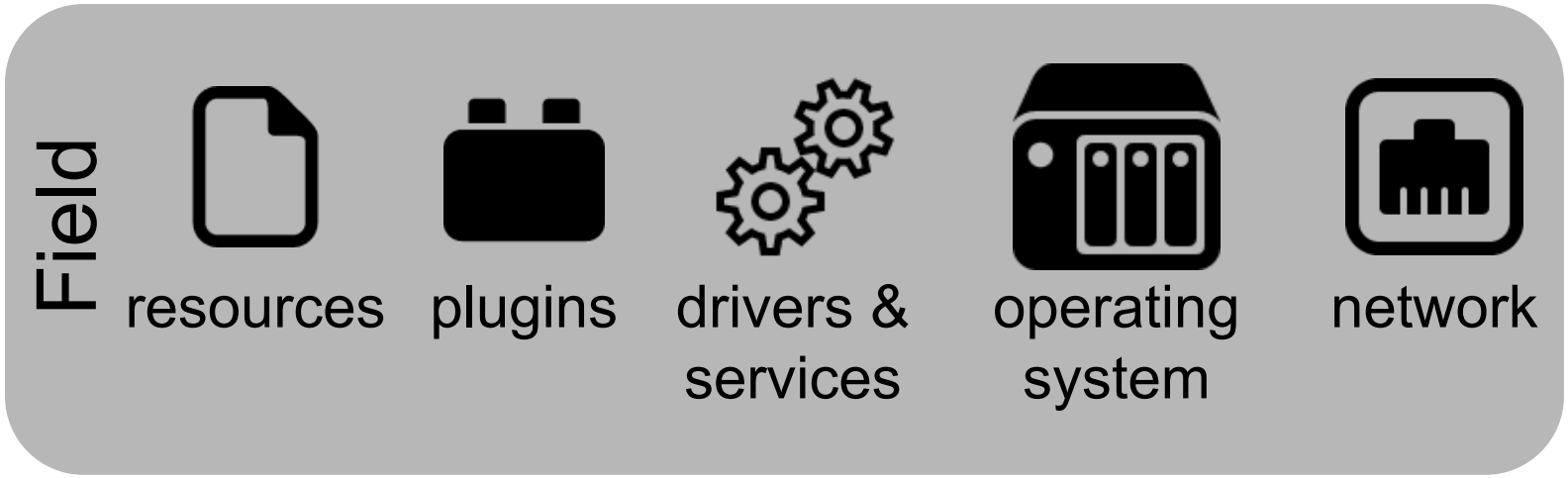
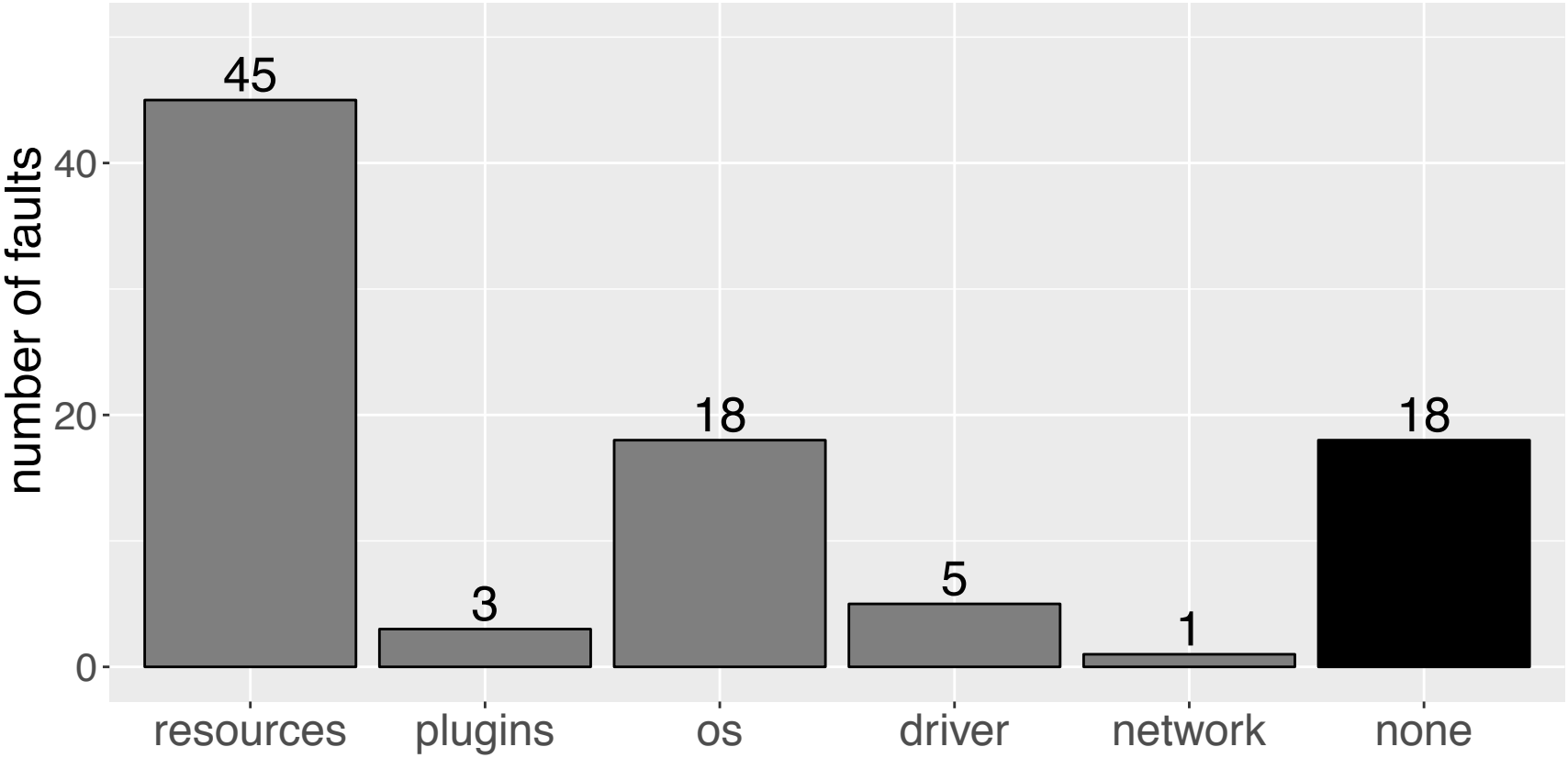


RQ2: Which elements of the field are involved in field failures?



RQ2: Which elements of the field are involved in field failures?

78% of field-only faults interact with a field element



Field Testing is Necessary

Key Challenges

- Test Strategy

- Non-intrusiveness

Key Challenges

- Test Strategy
  - Test Obligation

What to test?
- Complementary to Development Testing
- e.g. Integration with DBMS

- Non-intrusiveness

Key Challenges

- Test Strategy
  - Test Obligation
  - Test Opportunity

When to activate testing procedures?
- Software State
- Resources State

- Non-intrusiveness

Key Challenges

- Test Strategy
  - Test Obligation
  - Test Opportunity
  - Test Generation Strategy

How to generate test cases?
- Statically, in-house
- Dynamically, in the field

- Non-intrusiveness

Key Challenges

- Test Strategy
  - Test Obligation
  - Test Opportunity
  - Test Generation Strategy
  - Test Oracle

What to check
- General correctness properties
- Specific test behaviour

- Non-intrusiveness

Key Challenges

- Test Strategy
  - Test Obligation
  - Test Opportunity
  - Test Generation Strategy
  - Test Oracle
- Non-intrusiveness
  - Isolation
  - Limited Overhead

Proper Field Testing
Test Infrastructure

Example of A Concrete Test Strategy

- Test Obligation
  - cover functionalities working with objects mapped to external resources
- Test Opportunity
  - modified resource location (a resource is moved)
  - the framework continuously monitor the location of resources (e.g. files opened in previous Openoffice executions, or files belonging to a Eclipse project)
- Test Strategy
  - Developers' test suite that stress functions working with files

Ongoing Work

- Identification of Test Strategies from case studies
- Identification of Technologies to build a Field Testing Framework

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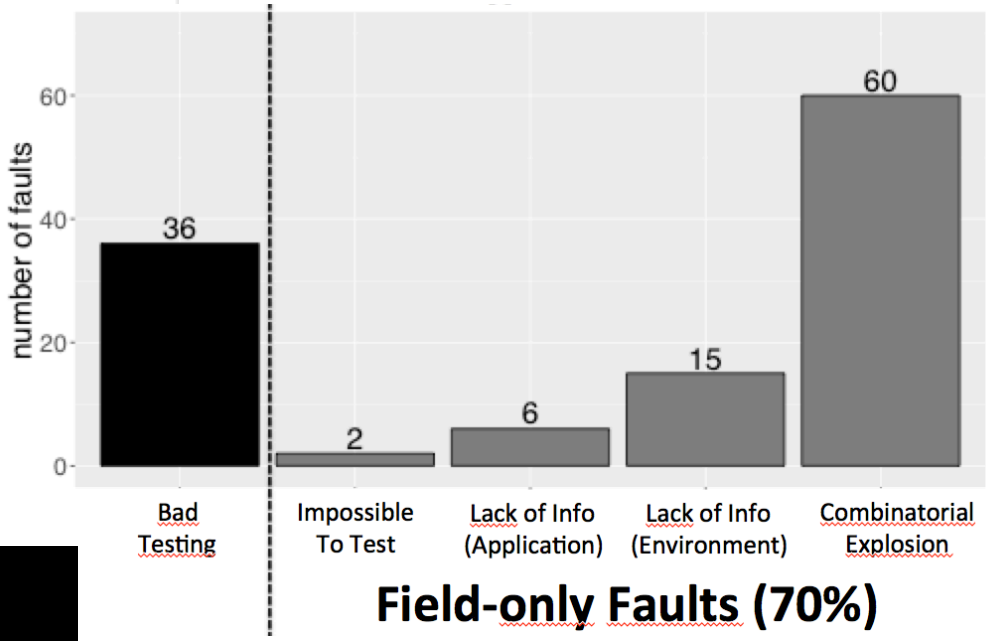

Ongoing: Field Testing Framework

RQ3: What kinds of field failures can be observed?

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- Failure Types
  - Value Failures
    - Invalid value
    - Out of domain
    - Error message
  - Timing Failures
    - Early timing
    - Late timing
    - Omission
  - System Failures
    - Halting failure
    - Crash
    - Unstable behavior
- Detactability
  - Signaled
  - Unhandled
  - Silent
  - Self-healed

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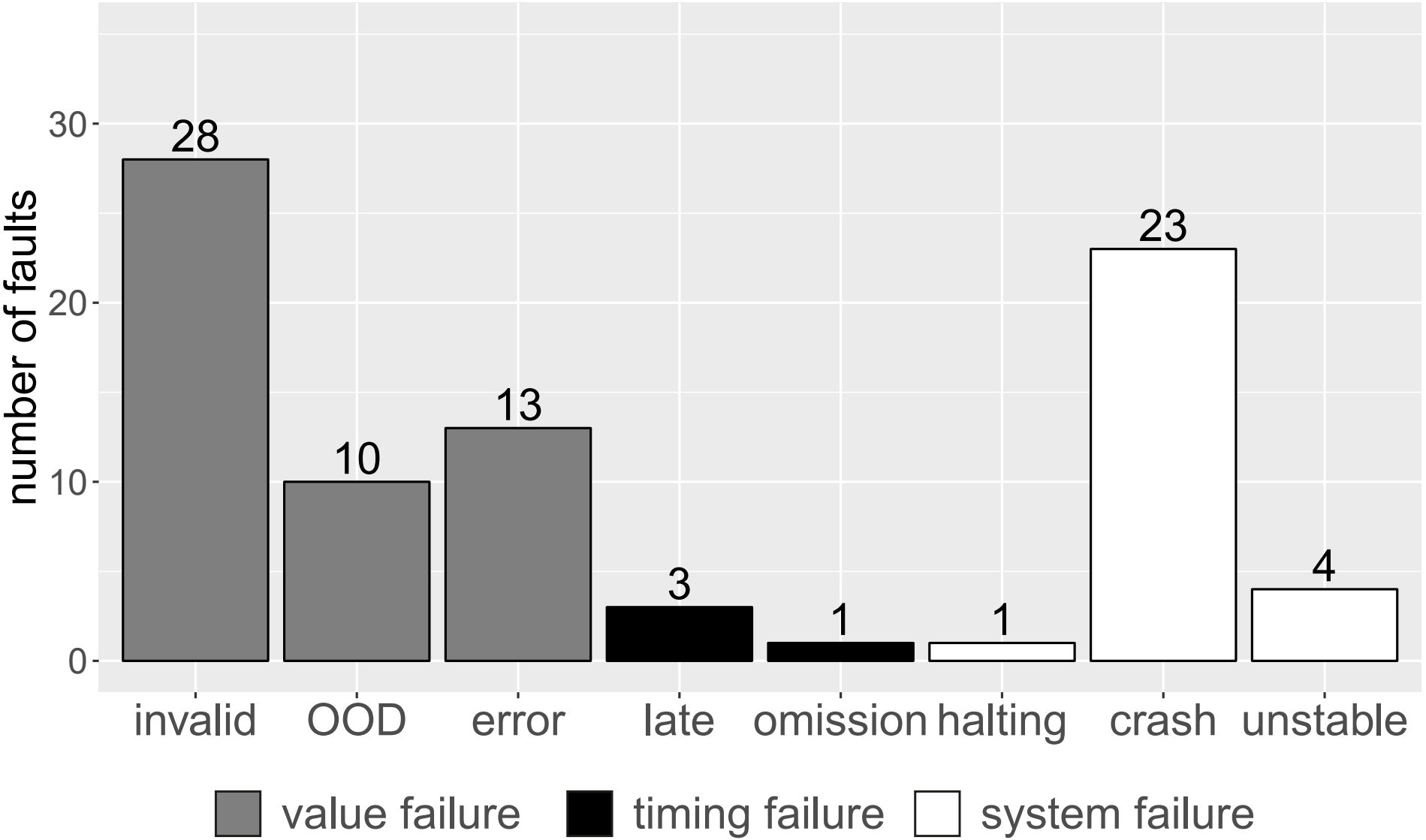

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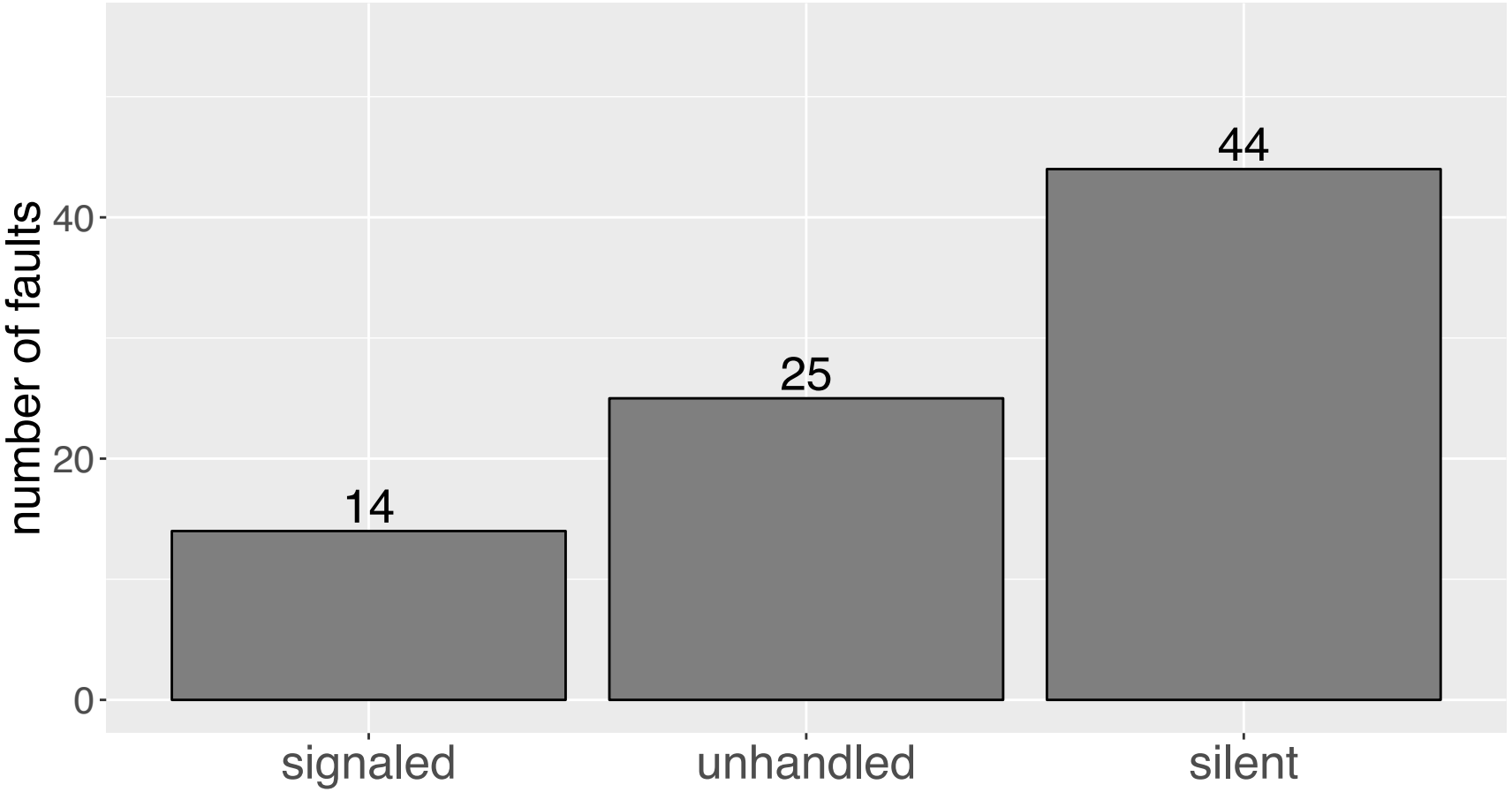

RQ4: How many steps are needed to reproduce a field failure?