

# Effects of Negative Testing on Test Driven Development

## An Industrial Experiment



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# About me

- *PhD Student @ Mälardalen University, Sweden*
- *First conference attended:*
  - *XP2008 in Limerick, Ireland*
- *Last conference (as PhD student):*
  - *XP2013 in Vienna, Austria*
  
- *Research topic: “Agile Testing” or “Testing in Agile”*
- *Specific focus on “developer’s testing skills”*
  
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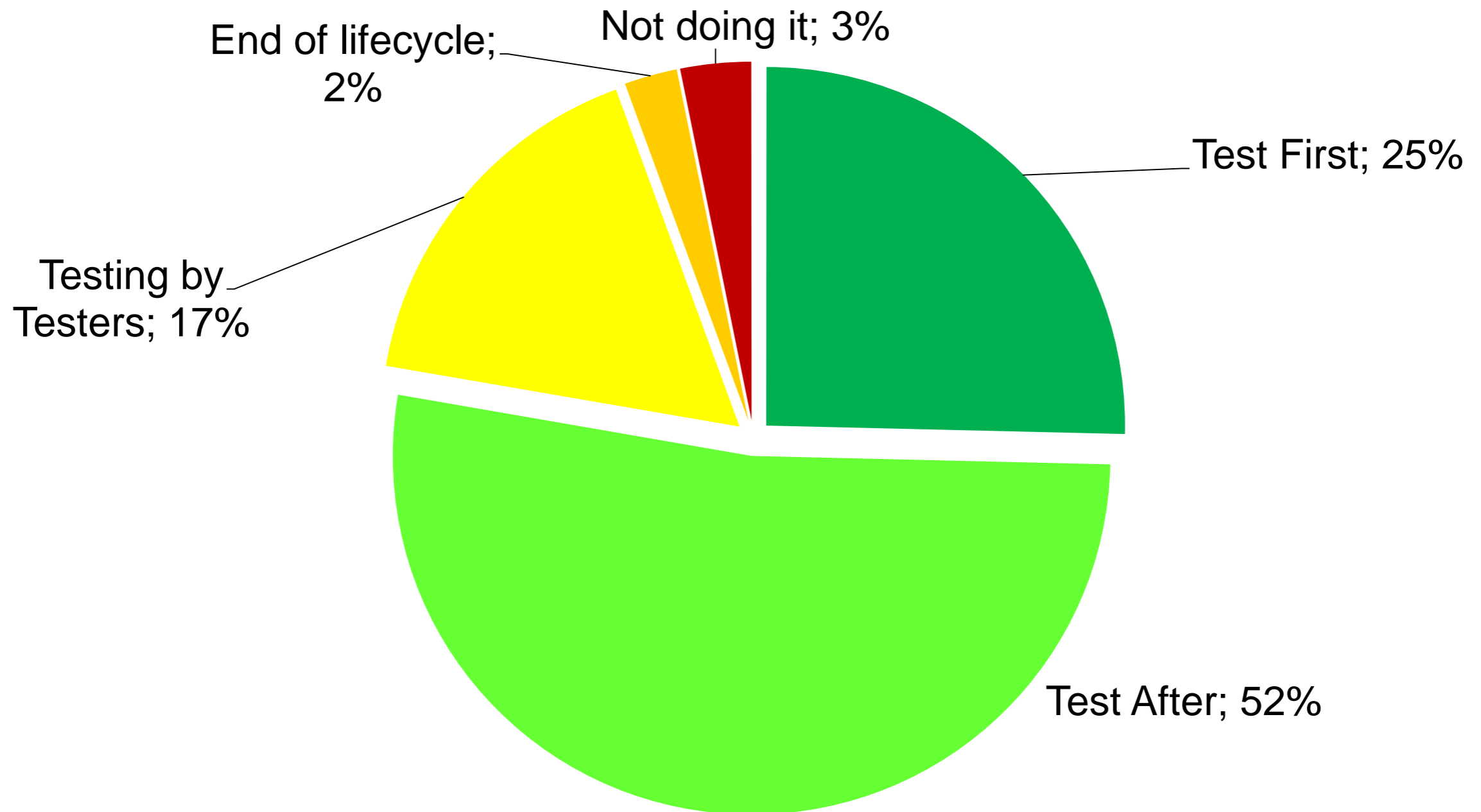
# Research Flow

***“Respondents would like to use TDD to a significantly higher extent than they actually do currently.”***

A. Causevic, D. Sundmark, and S. Punnekkat, **“An Industrial Survey on Contemporary Aspects of Software Testing,”** in Proceedings of the 3rd International Conference on Software Testing, Verification and Validation (ICST), 2010



# Primary Approach to Developer Testing





# Research Flow

***“Developers inability to write efficient and effective automated test cases is considered to be one of the limiting factors of full TDD adoption.”***

A. Causevic, D. Sundmark, and S. Punnekkat, **“Factors Limiting Industrial Adoption of Test Driven Development: A Systematic Review,”** in Proceedings of the 4th International Conference on Software Testing, Verification and Validation (ICST), 2011



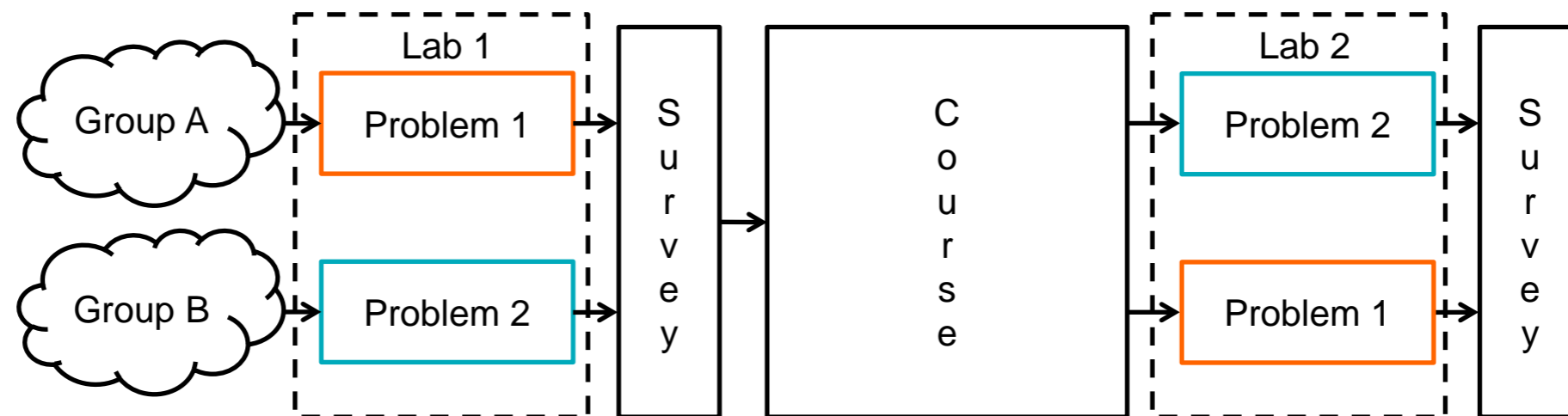
# Challenges Adopting Agile Testing Approaches

- *What has your team found to be the most difficult challenges when adopting agile testing approaches?*
- *50% Getting all testing done in the current iteration/sprint*
- **37% Adopting test-driven approaches**
- *33% Validating non-functional requirements*
- *33% Getting stakeholders/customers involved with testing*
- **27% Getting developers to test their own code**
- *21% User interface testing*
- *16% Learning to test throughout the lifecycle*
- *13% Adopting new agile testing tools*
- *12% Migrating existing testing and quality professionals to agile*
- *8% Using our existing testing tools to support agile development*
- *8% Remaining regulatory compliant*



# Developer's Testing Skills

- *Does improvements in testing knowledge leads to efficient TDD?*



- *Empirical Study at MDU within course on Software V&V*
- *General testing knowledge provided to students*
- *No significant difference observed*
- *Analysis pointed out lack of “negative” test cases*

A. Causevic, D. Sundmark, and S. Punnekkat, “**Impact of Test Design Technique Knowledge on Test Driven Development: A Controlled Experiment**,” in Proceedings of the 13<sup>th</sup> International Conference on Agile Software Development (XP), 2012



# Negative testing?

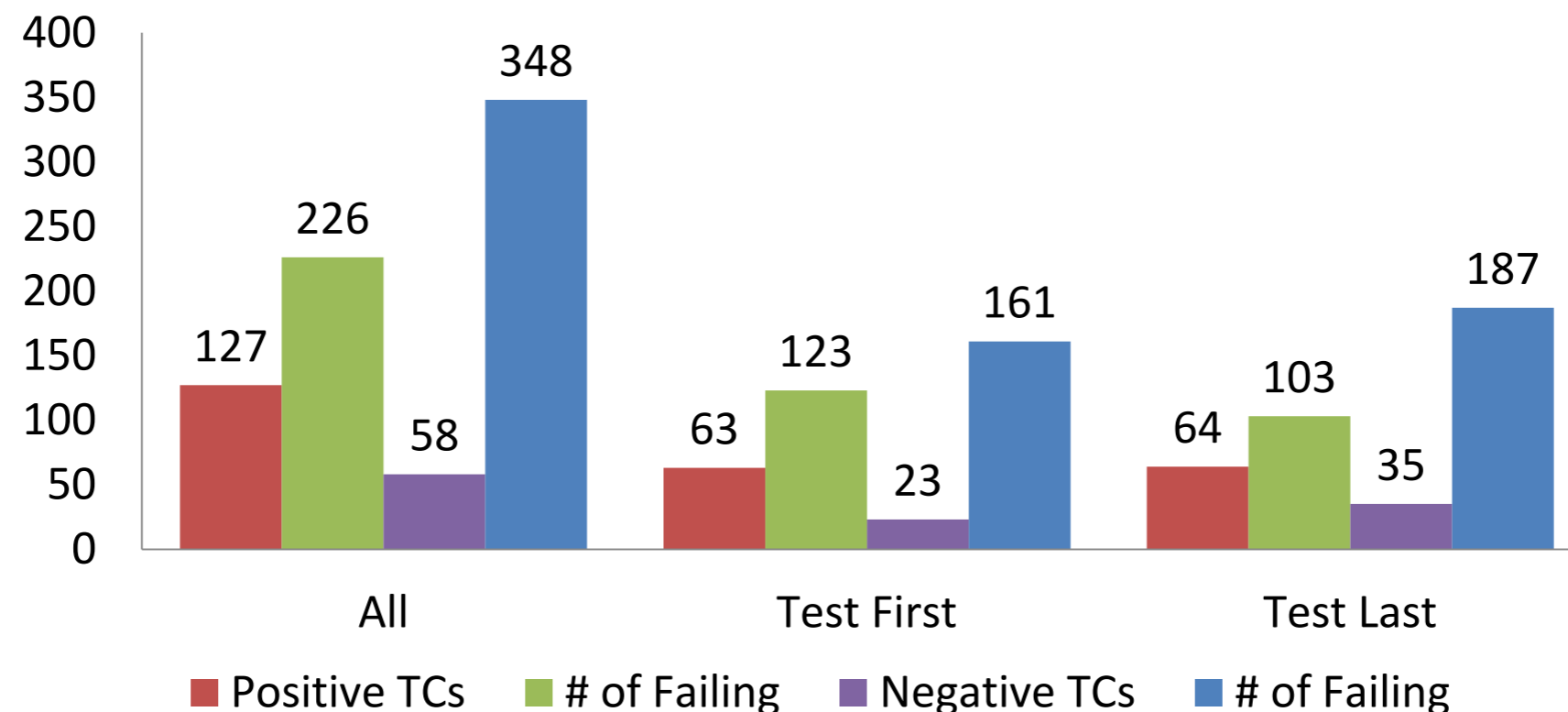
- *“... created for the purpose of exercising a program in a way that was not explicitly specified in the requirement.”*
- *Opposite of positive testing*
  - *“... exercises a program behaviour as it is specified in the requirement.”*





# Effect of Negative Testing on TDD

- *Study performed at MDU, Software V&V Course*
- *Existence of “positive test bias” acknowledged*
- *Importance of “negative” test cases (defect detecting ability is as much as **65%** higher than the positive ones)*



A. Causevic, D. Sundmark, and S. Punnekkat, “**Test Case Quality in Test Driven Development: A Study Design and a Pilot Experiment,**” in Proceedings of the 16<sup>th</sup> International Conference on Evaluation & Assessment in Software Engineering (EASE ), 2012



# Experiment Design



P1-Test Case 1	✓	✓
P1-Test Case 2	✓	✗
P1-Test Case 3	✓	✓



P2-Test Case 1	✓	✓
P2-Test Case 2	✗	✓
P2-Test Case 3	✗	✓

Infosys®





# Infosys InStep Internship program

Infosys® | InStep

- *infosys.com/instep*
- *Internship opportunities for students*
- *8-12 weeks duration*
- *Covering travel expenses, accommodation, monthly allowance, taxi, gym, etc...*
  
- *Perfect for visiting India 😊*



# My Infosys Internship

- *Placed in Bangalore DC, Infosys, India*
- *4 weeks in September 2012*
- *“Best Intern” award*
  
- *No time to visit anything ☹*



# Preparations for the Study

- *Started in May 2012*
- *Introduction to “Project Mentor” @ Infosys*
- *Original idea: Perform study on the specific day*
- *Mentor suggestion: Make study “open access” for at least 2 weeks*
  
- *Employees are distributed*
- *Employees will use their own workstations*
  - *Set of tools and instructions have to be provided*
  - *Internal server infrastructure setup*
  
- *Video training material for jUnit and TDD*
- *Internal promotion of the study*



# Research Questions

- ***RQ1:*** *Does the effect of positive test bias exist in an industrial context?*
- ***RQ2:*** *Is the defect detecting ability of negative test cases the same as the positive ones?*
- ***RQ3:*** *Is the quality of negative test cases the same as that of positive test cases?*
- ***RQ4:*** *Is there a difference in the quality of produced tests based on the usage of a specific development practice?*



# Study Execution

- *Experiment executed from 10<sup>th</sup> to 21<sup>st</sup> of Sept. 2012*
- *Around 100 participants placed in three groups*
  - *Test Last*
  - *Test Driven Development*
  - *Test Driven Development with the Support of Negative Testing*
- *Participants from: Bangalore, Beaverton, Brussels, Chennai, Hyderabad, Mangalore, Melbourne, Mysore, Pune, Trivandrum*





# Data collection

- *Solutions submitted by 60 participants*
- *Done when it's done*
  
- *Still, some removal was done:*
  - *Incomplete solutions*
  - *Own failing test cases*
  - *Small number of test cases ( $\leq 3$ )*
  - *Wrong test cases*
  - *Different programming interface*
  
- *33 solutions used for the analysis*

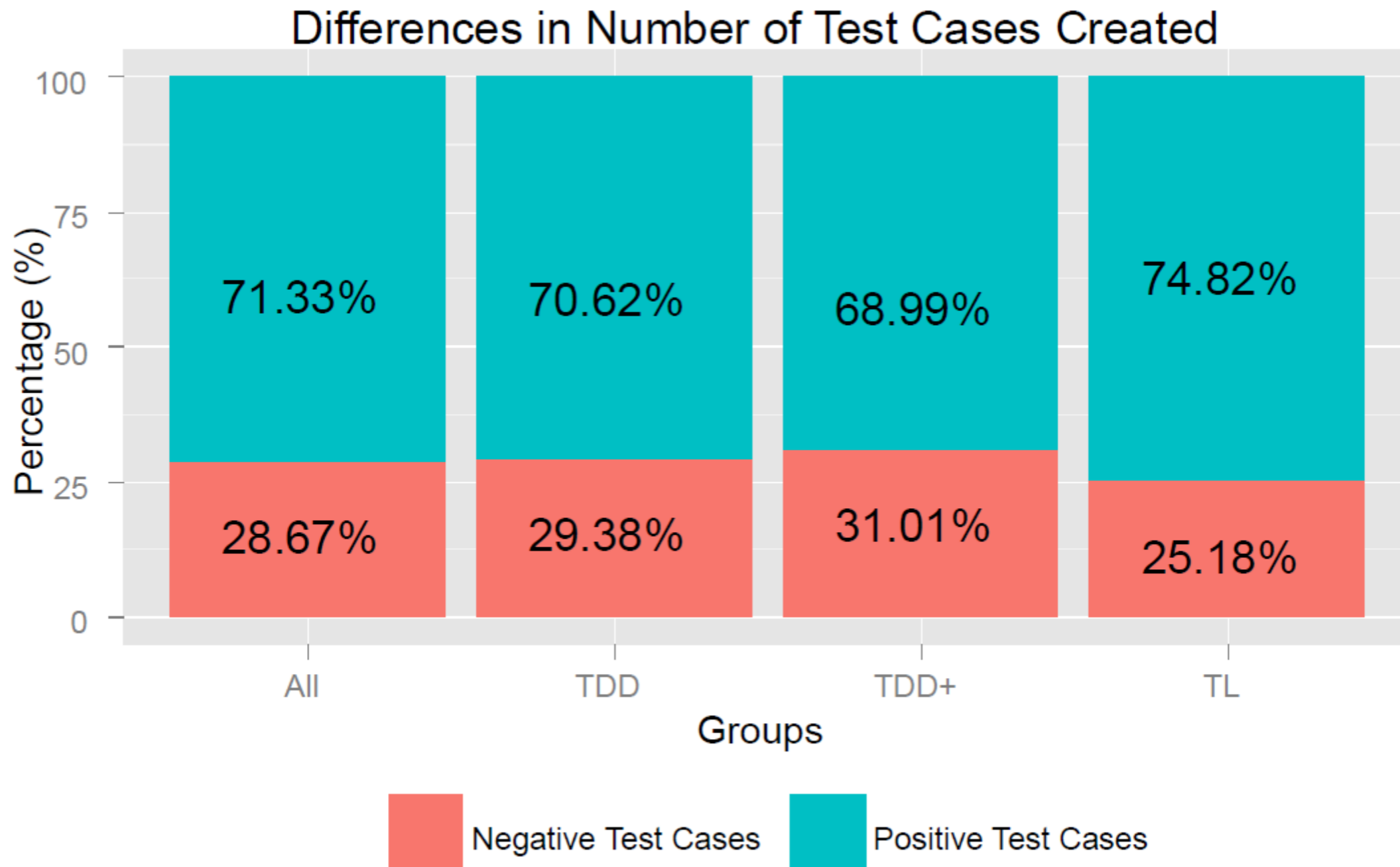


# Analysis

- ***RQ1:** Does the effect of positive test bias exist in an industrial context?*
  - p-value = 0.00000731
- ***RQ2:** Is the defect detecting ability of negative test cases the same as the positive ones?*
  - p-value = 0.00000302
- ***RQ3:** Is the quality of negative test cases the same as that of positive test cases?*
  - p-value = 0.00000277
- ~~***RQ4:** Is there a difference in the quality of produced tests based on the usage of a specific development practice?*~~
  - p-value = 0.4102955

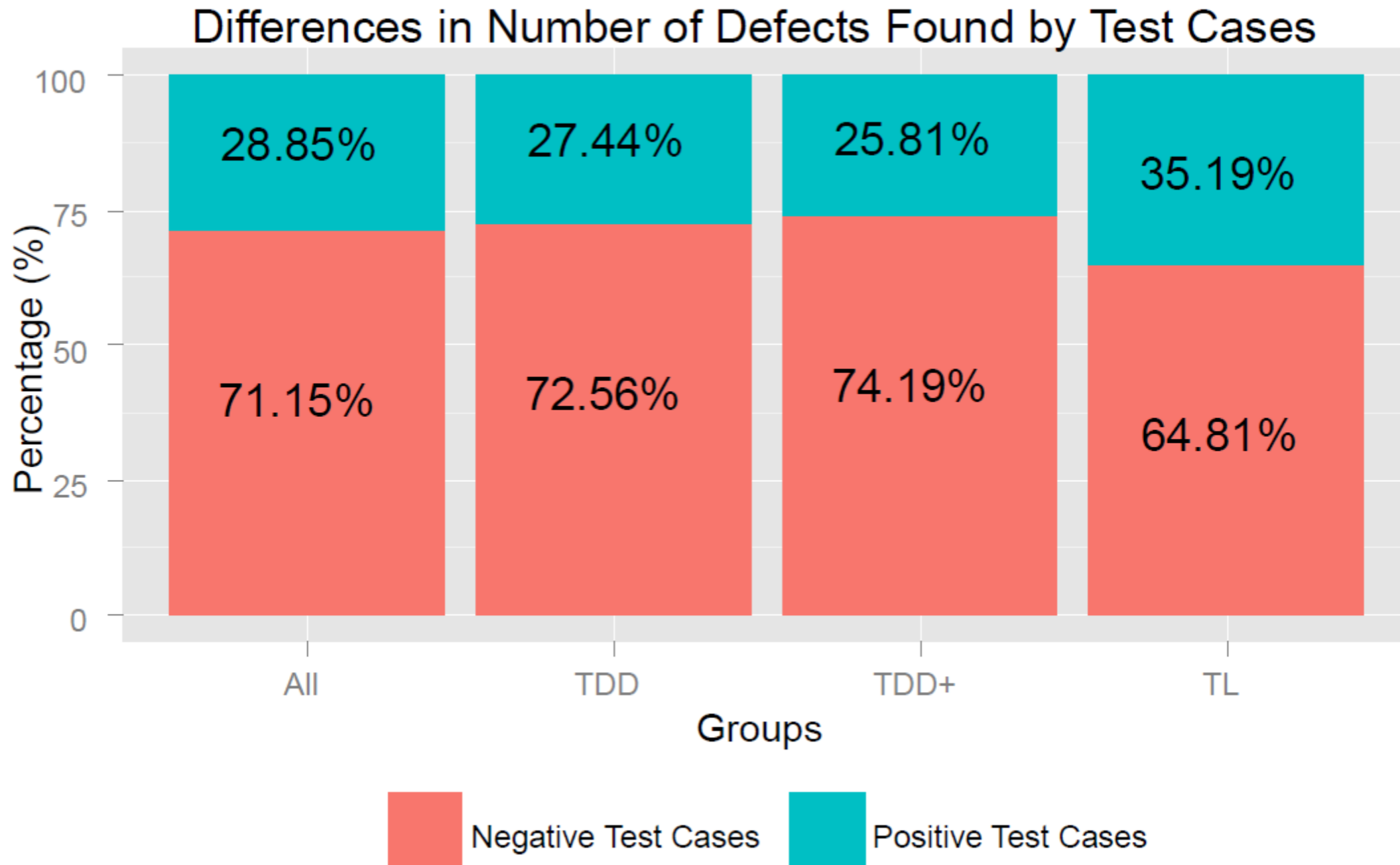


# Results





# Results





# Limitations

- *Inability to have a full controlled experiment*
- *Small scale problem (3 hours needed on average)*
- *Participants' (in)experience with TDD*
- *Narrowed sample size (only Infosys employees)*
- ...



# Benefits of the Study

- *Industrial perspective*
  - *Training provided to employees*
  - *Video tutorial currently used by training division*
  - *Corporate researchers collaborated with academia*
- *Academic perspective*
  - *Direct access to high number of employees*
  - *Collaboration with industry*
  - *Costs of performing the study*



# Lessons Learned

- *Employees are busy, use their time wisely!*
- *Curiosity and wiliness to learn something new*
- *Suspicion about being evaluated*



# Future Work

- *Further enhancements to TDD*
  - *Combining TDD with an appropriate test design techniques*
- *Empirical evaluation*
  - *Trial in academia*
  - *Full study in industry*



# Thank you!

Questions?



[www.mrtc.mdh.se/~acc01/infosys-experiment](http://www.mrtc.mdh.se/~acc01/infosys-experiment)

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