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**Reviewer's opinion  
on Ph.D. dissertation authored by**

*Tarek Alkhaeir*

**entitled:**

*Design patterns and code smells.  
Relationships and impact on selected  
software quality metrics*

**1. Problem and its impact**

This thesis examines the potential confounding impact that code smells play in the relationship between design patterns and software changeability and fault-proneness. By shedding light on this relationship, the candidate contributes to improving our understanding of the impact of design patterns on software quality. The results of the thesis contribute to raising the awareness of practitioners about the possibility of poor design occurring even in parts of the code where design patterns are implemented, and the consequences that this can have in terms of changeability and fault occurrence. Levering the results of the thesis, maintenance teams can better focus their code reviews and testing activities.

**2. Contribution**

This thesis examines the relationship between design patterns and code smells, as well as the impact of their co-occurrence on the changeability and defect proneness of software systems. The candidate first examined the relationship between design patterns and code smells in two medium-size Java systems and found that pattern classes tend to be affected by fewer smells than other classes. Next, he explored the relationship between design patterns and changeability and the confounding impact of code smells on this relationship. This second experiment is conducted on three medium-size open-source Java systems using 13 design patterns and 9 code smells. Finally, the candidate examined the relationship between design patterns and defects, and the confounding role that code smells play on this relationship, using 10 Java systems from the PROMISE dataset.

**3. Correctness**

Overall, the methodology followed by the candidate is sound and threats to validity are discussed carefully, which provides a good context for the interpretation of the reported results. However, there are some aspects of the analysis that should be clarified. For example, it is unclear if the metric `FREQ`

was normalized for the age of a project. This is important because older files are likely to experience more changes than a file with a shorter lifespan. The candidate claims that “in response to the issues mentioned for the change size, we adjusted the metrics for the number of revisions in the subject release”, but no precise details are provided in the thesis. The candidate also claims that he “adjusted the code churn values for both class size and the number of revisions in the respective release”, but again, no details are provided in the thesis. It would be interesting to see the precise formula that was used to compute the different metrics.

Also, since multiple hypotheses are tested on the same dataset, the candidate should consider applying a multiple-comparison correction, such as the Bonferroni correction.

Also, it would have been interesting to take into account the number of roles played by the classes in the studied design patterns, since previous studies reported significant differences between the changeability of classes playing zero, one, or two roles (see <https://ieeexplore.ieee.org/abstract/document/5306327>).

The candidate should explain in the thesis why the same systems, patterns, and smell types were not used for the three experiments. The use of a consistent experimental framework throughout the thesis would strengthen the results.

#### **4. Knowledge of the candidate**

Through the work, the candidate has demonstrated a good knowledge of empirical study, design patterns and code smells literature, and statistical analysis.

Overall, the structure of the thesis is adequate. I really enjoyed reading it! The thesis is built on research papers that are already published. Besides some typos in certain chapters, the writing of the thesis is good.

#### **5. Other remarks<sup>1</sup>**

Below are some typos that should be fixed:

metric of all the the systems → metric of all the systems

we test if classes with a a pattern → we test if classes with a pattern

the size of changes for pattern classes are bigger than for the

non-pattern classed → the size of changes for pattern classes are bigger than for the

non-pattern classes

This finding may help software developers in prioritizing → This finding may help software developers in prioritizing

Missing references to fix:

This is in line with the Open-Closed principle [?]

Data Classes have not been found to be related with increased maintenance effort [? ]

Data Classes have not been found to be related with increased maintenance effort [? ]

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<sup>1</sup> Optional

hey could be more stable, indifferent and more change-prone than other classes [? ].

## 6. Conclusion

Taking into account what I have presented above and the requirements imposed by Article 13 of the *Act of 14 March 2003 of the Polish Parliament on the Academic Degrees and the Academic Title* (with amendments)<sup>2</sup>, my evaluation of the dissertation according to the three basic criteria is the following:

A. Does the dissertation present an original solution to a scientific problem? (the selected option is marked with X)

*Definitely YES*

*Rather yes*

*Hard to say*

*Rather no*

*Definitely NO*

B. After reading the dissertation, would you agree that the candidate has general theoretical knowledge and understanding of the discipline of **Information and Communication Technology**, and particularly the area of ....?

*Definitely YES*

*Rather yes*

*Hard to say*

*Rather no*

*Definitely NO*

C. Does the dissertation support the claim that the candidate is able to conduct scientific work?

*Definitely YES*

*Rather yes*

*Hard to say*

*Rather no*

*Definitely NO*



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*Signature*

<sup>2</sup> [http://www.nauka.gov.pl/g2/oryginal/2013\\_05/b26ba540a5785d48bee41aec63403b2c.pdf](http://www.nauka.gov.pl/g2/oryginal/2013_05/b26ba540a5785d48bee41aec63403b2c.pdf)