Application of TMMi to improve test approaches and processes: Experience from two Turkish companies

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Outline

- Who we are, and a summary of our experience in software-testing
- Brainstorming: How can we improve our software-testing activities and practices?
- A short review of TMMi
- Application of TMMi to improve test approaches and processes: Experience from two Turkish companies
- Excerpts from the recent 2020 TMMi global survey
- Overview of the “other” 58 testing maturity models
- Summary and recommendations
- Further reading about TMMi
# About us - Vahid Garousi

## Work experience:

<table>
<thead>
<tr>
<th>Position</th>
<th>Institution</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Associate Professor</td>
<td>Queen's University Belfast, UK</td>
<td>since 2019-</td>
</tr>
<tr>
<td>Managing Consultant</td>
<td>Bahar Software Engineering Consulting</td>
<td>since 2001-</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>Wageningen University, Netherlands</td>
<td>2017-2019</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>Hacettepe University, Ankara, Turkey</td>
<td>2015-2017</td>
</tr>
<tr>
<td>Associate Professor</td>
<td>University of Calgary, Canada</td>
<td>2006-2014</td>
</tr>
<tr>
<td>Software Engineer</td>
<td>Offshore office of Corsha Software Inc., Quebec, Canada</td>
<td>based in: Tehran, Iran, 1998-2001</td>
</tr>
</tbody>
</table>

## Education:

<table>
<thead>
<tr>
<th>Degree</th>
<th>Institution</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>PhD</td>
<td>Carleton University, Ottawa, Canada</td>
<td>2006</td>
</tr>
<tr>
<td>MSc</td>
<td>University of Waterloo, Canada</td>
<td>2003</td>
</tr>
<tr>
<td>BSc</td>
<td>Sharif University of Technology, Tehran, Iran</td>
<td>2000</td>
</tr>
</tbody>
</table>

![Map of Canada, United Kingdom, and Turkey]
# About us- Alper Buğra Keleş

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<tr>
<th>Position</th>
<th>Company/Location</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Leader</td>
<td>Testinium A.Ş., Istanbul, Turkey,</td>
<td>since 2017-</td>
</tr>
<tr>
<td>IT Analyst</td>
<td>ekin Technology, Dubai, UAE,</td>
<td>2015 – 2017</td>
</tr>
<tr>
<td>IT Analyst</td>
<td>Turkey Medical Information Systems A.Ş., Istanbul</td>
<td>2014 – 2015</td>
</tr>
<tr>
<td>Software Engineer</td>
<td>Tacit Knowledge Corp., San Francisco, California</td>
<td>2012–2013</td>
</tr>
</tbody>
</table>

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<tr>
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<th>Institution</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSc Computer Engineering</td>
<td>Istanbul University</td>
<td>2011</td>
</tr>
</tbody>
</table>

- Some of the major products in which he has led the test automation projects for:

- BtcTurk
- eBay
- beIN
- Udemy
- Allianz
- ING
- SHERBANK
- trendyol
- TURKCELL
- Garanti BBVA
- hepsiburada
- PEGASUS
- ANADOLU SIGORTA
- Bluefin
- axs
- beko

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Dr. Vahid Garousi – Alper Buğra Keleş
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Effectiveness and efficiency of / in software testing

- **Higher / Better test effectiveness**: Detecting more defects by our test activities (designing “better” / “right” test cases)

- **Higher / Better test efficiency**: Executing more tests faster (in less time). “Doing testing right” (see above)

slideshare.net/ScottWlaschin/the-theory-of-chains
Let’s hear from you…

How do you improve effectiveness and efficiency of software testing in your team / company?

Join at slido.com #777
Can we do a better job in software testing?

- Many of us improve our team’s software testing practices in ad-hoc manners, e.g., trying any “random” test approach after reading online about it.

- But can we do it more systematically?
  - The answer is Yes!

- Using the so-called test “maturity models”:
  - 1-Testing Maturity Model integrated (TMMi) model
  - 2-Test Process Improvement (TPI) model
  - ...
  - 58-(and there are at least 58 such “models”!) – we did a “survey” of them in 2018. Will see a brief review of them later in this talk.
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Testing Maturity Model integrated (TMMi) model

- It is a “benchmark” which can consistently “grade” teams for their testing maturity

Maturity levels

(1) Initial
- Test Policy and Strategy
- Test Planning
- Test Monitoring and Control
- Test Environment

(2) Managed
- Test Policy and Strategy
- Test Planning
- Test Monitoring and Control
- Test Design and Execution
- Test Environment

(3) Defined
- Test Organization
- Test Training Program
- Test Lifecycle and Integration
- Non-functional Testing
- Peer Reviews

(4) Measured
- Test Measurement
- Software Quality Evaluation
- Advanced Peer Reviews

(5) Optimization
- Defect Prevention
- Test Process Optimization
- Quality Control

More maturity

Less maturity

Developed by the TMMi foundation

www.tmmi.org
An overview of TMMi

- **Structure:**

  - (1) Initial
  - (2) Managed
    - Test Policy and Strategy
    - Test Planning
    - Test Monitoring and Control
    - Test Design and Execution
    - Test Environment
  - (3) Defined
    - Test Organization
    - Test Training Program
    - Test Lifecycle and Integration
    - Non-functional Testing
    - Peer Reviews
  - (4) Measured
    - Test Measurement
    - Software Quality Evaluation
    - Advanced Peer Reviews
  - (5) Optimization
    - Defect Prevention
    - Test Process Optimization
    - Quality Control

Maturity levels

Process areas (PAs)

Increase in maturity

Let's discuss a few of the elements next...
## An overview of TMMi

<table>
<thead>
<tr>
<th>Levels</th>
<th>Process areas</th>
<th>Specific goals and specific practices</th>
<th># of SGs, SPs (PA level)</th>
</tr>
</thead>
</table>
| Level 2: Managed        | PA 2.1 Test policy and strategy | • SG 1 Establish a test policy  
  o SP 1.1 Define test goals  
  o SP 1.2 Define test policy  
  o SP 1.3 Distribute the test policy to stakeholders  
• SG 2 Establish a test strategy  
  o SP 2.1 Perform a generic product risk assessment  
  o SP 2.2 Define test strategy  
  o SP 2.3 Distribute the test strategy to stakeholders  
• SG 3 Establish test performance indicators  
  o SP 3.1 Define test performance indicators  
  o SP 3.2 Deploy test performance indicators                                                                                                                  | 3, 8                     |
|                         | PA 2.2 Test planning        | • SG 1 Perform a product risk assessment  
  o SP 1.1 Define product risk categories and parameters  
  o SP 1.2 Identify product risks  
  o SP 1.3 Analyze product risks  
• SG 2 Establish a test approach  
  o SP 2.1 Identify items and features to be tested  
  o SP 2.2 Define the test approach  
  o SP 2.3 Define entry criteria  
  o SP 2.4 Define exit criteria  
  o SP 2.5 Define suspension and resumption criteria                                                                                                       | 5, 19                    |

Each SP is assessed:
1. **Not applicable (N/A)**
2. **Not implemented (NI)**
3. **Partially implemented (PI)**
4. **Largely implemented (LI)**
5. **Fully implemented (FI)**
An overview of TMMi

- For more details, see its full specification online...
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  - Process and “context” for test maturity assessment (TMA) and test process improvement (TPI)
  - Review of TMA / TPI project #1-Client #1
  - Review of TMA / TPI project #2-Client #2
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Process for test maturity assessment (TMA) and test process improvement (TPI)

From a 2018 paper of ours, available online:
The 1st project of applying TMMi-Client #1

- Client: A large software company in Turkey. Had a team of 45+ test engineers, and about 500 software developers (company name: undisclosed). The company had CMMI-3 certification.

- The work was done in the scope of a consulting project in 2016, in which the request of the client company was to conduct an “informal assessment” using TMMi.

- Company’s objective: to improve software testing practices: to improve Effectiveness and efficiency of software testing.

- Results:

  - Question: So, which TMMi level is this company in?
  - How we did it (how we assessed each process area)? Discussed next...
### The 1st project of applying TMMi: Howe was it done?

<table>
<thead>
<tr>
<th>Process Area (PA)</th>
<th>Specific Goal (SG)</th>
<th>Specific Practice (SP)</th>
<th>Explanation</th>
<th>Supporting artifacts</th>
<th>Score</th>
<th>Opportunity for TPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA 2.3-Test monitoring and control</td>
<td>SG 1-Monitor test progress against plan</td>
<td>SP 1.1-Monitor test planning parameters</td>
<td>Monitor the actual values of the test planning parameters against the test plan. Sub practices: - Monitor test progress against the test schedule - Monitor the test cost and expended test effort - Monitor the attributes of the test work products and test tasks - Monitor the knowledge and skills of test staff - Document the significant deviations in the test planning parameters.</td>
<td>The company has test tracking sheets; Causal Analysis and Resolution Reports, task control system</td>
<td>FI</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>SP 1.2-Monitor test environment resources provided and used</td>
<td>Monitor the actual usage of the provided test environment resources against the plan</td>
<td>The company has Project test plan, project progress meetings</td>
<td>LI</td>
<td>Should improve the monitoring of the actual usage of the provided test environment resources against the plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SP 1.3-Monitor test commitments</td>
<td>Monitor test commitments achieved against those identified in the test plan.</td>
<td>The company has Project progress meeting records (internal), project management meetings (external)</td>
<td>FI</td>
<td></td>
</tr>
</tbody>
</table>

Each SP is assessed:
1. Not applicable (N/A)
2. Not implemented (NI)
3. Partially implemented (PI)
4. Largely implemented (LI)
5. Fully implemented (FI)
The 1st application project of TMMi: Benefits to the client?

- Assessment using TMMi helped us to pinpoint areas for Test Process Improvement (TPI), which itself led to several separate / follow-up TPI projects

- Some concrete examples of TPI for the client:
  1. Separation of debugging from testing should be made more clear in test policy documents
  2. There is a need to document product risks in test documents
  3. Test policy and test performance indicators and metrics could be updated
  4. There is a need for more systematic risk-based testing
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The 2\textsuperscript{nd} project of applying TMMi and test process improvement (TPI) -Client #2

- **Client:** Testinium A.Ş.: a large software-testing company in Turkey
- **As of 2021,** Testinium has a large team of 200+ test engineers
- The work has been done in the scope of a consulting engagement and a large EU R&D project (named TESTOMAT), since 2019 and still ongoing.
- Company’s objective: to improve software testing practices in general, and to improve **Effectiveness** and **efficiency** of software testing
- The approach for test maturity assessment (TMA) and test process improvement (TPI) has been quite focused, compared to the project #1 (reviewed in the past slides)
  - Focus of work →
  - More details next…

Dr. Vahid Garousi – Alper Buğra Keleş
The 2nd project of applying TMMi and test process improvement (TPI) - Client #2

- (1) Initial
  - Test Policy and Strategy
  - Test Planning
  - Test Monitoring and Control
  - Test Design and Execution
  - Test Environment

- (2) Managed
  - Test Policy and Strategy
  - Test Planning
  - Test Monitoring and Control
  - Test Design and Execution
  - Test Environment

- (3) Defined
  - Test Organization
    - Test Training Program
    - Test Lifecycle and Integration
    - Non-functional testing
    - Peer Reviews

- (4) Measured
  - Test Measurement
    - Software Quality Evaluation
    - Advanced Peer Reviews

- (5) Optimization
  - Defect Prevention
  - Test Process Optimization
  - Quality Control

Prioritization of regression tests
Coverage measurement of both front- and back-end

- Increase in maturity
- Modeling-based testing
- Systematic test-case design for the BDD "Gauge" framework
- Integration of automated tests into CI/CD pipelines (a best practice)

... of all the techniques that we have developed and deployed
The 2\textsuperscript{nd} application project of TMMi and test process improvement (TPI): Do you want to know our approaches?

- We have presented our test innovations in various papers and talks. Most are accessible online. Videos are in: bit.ly/VideosMBTTestinium
- Papers below can easily be found by Google search for their titles
The 2\textsuperscript{nd} application project of TMMi and test process improvement (TPI): \textbf{Benefits} to the client?

\begin{itemize}
\item \textbf{Tangible benefits:}
  \begin{itemize}
  \item Increased test effectiveness in detection of real faults
  \item Improved test-case design practices, due to MBT
  \item Ability to systematically assess requirements coverage by using MBT
  \end{itemize}
\item \textbf{Intangible but important benefits, e.g.:}
  \begin{itemize}
  \item MBT made the work of test engineers more “interesting”, and more organized.
  \item … thanks to MBT models, test engineers can now see the “big picture” of test-case design much more easily with having the test models in front of them, and the model being directly executable.
  \end{itemize}
\end{itemize}
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The recent 2020 TMMi global survey

- The survey’s goal:
  □ to get a detailed understanding of the benefits of the TMMi
  □ and, the reasons/motivations for adopting TMMi

- The survey was designed and executed by the TMMi Foundation
  □ (Vahid was actively involved in the survey)

- Survey design:
  □ It had 21 questions in total.
  □ 6 questions were about the demographic information of the participants, e.g., size of the organization.
  □ 1 question was about motivations for adopting TMMi
  □ 2 questions were about benefits of adopting TMMi
  □ 3 questions were about challenges when applying the TMMi
  □ The survey was online (hosted on Google forms).
  □ The full survey instrument can be found in doi.org/10.5281/zenodo.4434119.
The recent 2020 TMMi global survey

- **Survey execution:**
  - In Summer 2020, we sent email invitations to all the 114 companies that had by then been formally assessed through the TMMi Foundation.
  - 74 companies/teams responded to the survey, thus yielding a survey response rate of **64.9%**.

- **Respondents’ demographics:**

  ![Bar chart showing the number of participants by region and industry.]
  
  - **Asia:** 37 participants
  - **Europe:** 25 participants
  - **North America:** 8 participants
  - **Middle America:** 2 participants
  - **South America:** 8 participants
  - **Middle East:** 1 participant
  - **Africa:** 0 participants
  - **Australia / New Zealand:** 0 participants
  
  - **IT / Software:** 29 participants
  - **Financial services:** 26 participants
  - **Professional services:** 5 participants
  - **Telecommunications:** 4 participants
  - **Government:** 3 participants
  - **Retail:** 2 participants
  - **Healthcare:** 2 participants
  - **Automotive:** 2 participants
  - **Non-profit:** 1 participant
The recent 2020 TMMi global survey

- **Motivations for adopting TMMi:**

<table>
<thead>
<tr>
<th>Motivation</th>
<th>Num. of participants (total=74)</th>
</tr>
</thead>
<tbody>
<tr>
<td>To enhance software quality</td>
<td>70%, 52</td>
</tr>
<tr>
<td>To increase testing productivity</td>
<td>68%, 50</td>
</tr>
<tr>
<td>To reduce product risk</td>
<td>62%, 46</td>
</tr>
<tr>
<td>To achieve TMMi certification</td>
<td>62%, 46</td>
</tr>
<tr>
<td>To achieve standard compliance</td>
<td>46%, 34</td>
</tr>
<tr>
<td>To improve delivery predictability</td>
<td>43%, 32</td>
</tr>
<tr>
<td>To improve test engineering discipline</td>
<td>43%, 32</td>
</tr>
<tr>
<td>To meet customer requirements</td>
<td>32%, 24</td>
</tr>
<tr>
<td>To improve team morale</td>
<td>28%, 21</td>
</tr>
<tr>
<td>To accelerate software delivery</td>
<td>27%, 20</td>
</tr>
<tr>
<td>To improve business alignment</td>
<td>27%, 20</td>
</tr>
<tr>
<td>To reduce project costs</td>
<td>18%, 13</td>
</tr>
</tbody>
</table>
The recent 2020 TMMi global survey

- **Benefits of adopting TMMi:**

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Num. of participants (total=74)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhanced software quality</td>
<td>72%, 53</td>
</tr>
<tr>
<td>Increase testing productivity</td>
<td>69%, 51</td>
</tr>
<tr>
<td>Reduced product risk</td>
<td>66%, 49</td>
</tr>
<tr>
<td>Accelerated software delivery</td>
<td>30%, 22</td>
</tr>
<tr>
<td>Improved business alignment</td>
<td>36%, 27</td>
</tr>
<tr>
<td>Improved delivery predictability</td>
<td>39%, 29</td>
</tr>
<tr>
<td>Reduced project costs</td>
<td>19%, 14</td>
</tr>
<tr>
<td>Improved team morale</td>
<td>50%, 37</td>
</tr>
<tr>
<td>Improved test engineering discipline</td>
<td>55%, 41</td>
</tr>
<tr>
<td>Met customer requirements</td>
<td>30%, 22</td>
</tr>
<tr>
<td>Standardized compliance</td>
<td>51%, 38</td>
</tr>
<tr>
<td>Achieved TMMi certification</td>
<td>68%, 50</td>
</tr>
</tbody>
</table>
Two papers are being written out of the 2020 TMMi survey data

- Will be submitted and published soon (one short, and one full paper)

Motivations for and benefits of adopting the Test Maturity Model integration (TMMi): An international survey

Vahid Garousi
Bahar Software Engineering Consulting Limited

Erik van Veenendaal
TMMi Foundation

Michael Felderer
University of Innsbruck
Blekinge Institute of Technology

IEEE Software
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In addition to TMMi, how many other test maturity models exist?

- We asked this question when attempting to assess the testing maturity of a client
- **Answer:** We conducted a systematic survey in 2015 and found **58** models
- We published our survey as a paper

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**What We Know about Software Test Maturity and Test Process Improvement**

Vahid Garousi, Hacettepe University
Michael Folding, University of Innsbruck
Tuna Hazaloglu, Atılım University

// A review of the scientific literature and practitioners’ grey literature identified 58 test maturity models and many sources of evidence for their effectiveness. Unfortunately, however, many companies’ testing practices are far from mature and are usually conducted in an ad hoc fashion. Such immature practices lead to negative outcomes—for example, testing that doesn’t detect all the defects or that incurs cost and schedule overruns.

To determine the efficiency, effectiveness, and quality of testing practices, companies and software teams often perform test maturity assessment (TMA). As a follow-up, test engineers and managers often perform test process improvement (TPI). To conduct TMA and TPI systematically, researchers and practitioners have proposed various approaches and frameworks, such as the approaches described in the recent book *Improving the Test Process: Implementing Improvement and Change*. This book forms the basis for the International Software Testing Qualifications Board (ISTQB) expert-level certification on TPI.

In collaborations with practitioners and in the context of several TPI projects in which we’ve been involved, we’ve come to realize that testers and managers inter-
Each item below is a testing maturity model! 58 of them.
Lines show the relationship among models.
Let’s look at a few of those 58 testing maturity models

<table>
<thead>
<tr>
<th>Targeted for specific development types or domains</th>
<th>Agile Quality Assurance Model (AQM) [S3]</th>
<th>Staged: Level 1. Initial Level 2. Performed Level 3. Managed Level 4. Optimized</th>
</tr>
</thead>
</table>
Let’s look at a few of those 58 testing maturity models

| Targeted for specific test activities | Unit Test Maturity Model (UTMM) [S156] | Staged:  
| | | Level 0. Ignorance  
| | | Level 1. Few Simple Tests  
| | | Level 2.Mocks and Stubs  
| | | Level 3. Design for Testability  
| | | Level 4. Test-Driven Development  
| | | Level 5. Code Coverage  
| | | Level 6. Unit Tests in the Build  
| | | Level 7. Code Coverage Feedback Loop  
| | | Level 8. Automated Builds and Tasks  
| Automated Software Testing Maturity Model (ASTMM) [S5] | Staged:  
| | | Level 1. Accidental Automation  
| | | Level 2. Beginning Automation  
| | | Level 3. Intentional Automation  
| | | Level 4. Advanced Automation  
| Personal Test Maturity Matrix (PTMM) [S151] | Continuous. Comprises a set of KPAs such as test execution, automated test support, and reviewing. |
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Summary and recommendations

- Our experience in application of TMMi and other test maturity models to improve test approaches and processes has been very successful.

- If planned and executed properly, test maturity assessment (TMA) and test process improvement (TPI) can REALLY provide benefits for test team and companies.

- If you need help, we can help!
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Further reading about TMMi

- TMMi’s website has a LOT of useful information

- Especially, the “case studies” would be useful for those who “consider” applying TMMi
Further reading about TMMi

- A new 2021 paper by us...

Test Maturity Model integration (TMMi):
Trends of worldwide test maturity and certifications

Vahid Garousi
Queen's University Belfast
Bahar Software Engineering Consulting Limited

Erik van Veenendaal
TMMi Foundation

Abstract:
Test Maturity Model integration (TMMi) is a popular model for maturity assessment and capability improvement of software testing practices in industry. Originally inspired by the Capability Maturity Model Integration (CMMI), the TMMi guidelines for assess capabilities of teams at this paper a status report and benefits of using TMMi been ranked in each of it

Informal assessments
Formal assessments
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