Designing and Developing Performance Measurement Software Solution

Bekim Fetaji, and Majlinda Fetaji

Abstract— The focus of the research study is the development of a software solution for performance evaluation system. In order to test the developed methodology for performance evaluation a software solution is created, implemented and tested. The methodology includes applying different patterns, structural definitions and creating multi-layered application that will follow the defined code standards. The research study contributes with the analyses, insights and recommendations as well as with the new proposed methodology for developing performance evaluation systems as well as with the conceptual design that led to implemented solution that serves for evaluation processes. Another contribution that the study tries to make is the extensibility of the solution and it can become a good reference point for further researches in developing performance evaluation.

Keywords— Performance measurements, web software solution, design patterns, evaluation processes.

I. INTRODUCTION

In answering the question, ‘what is performance measurement?’ it is useful to start with definitions which have been used in the published research literature. According to Neely “Performance measurement is a topic often discussed but rarely defined”. The following proposed definitions concerning performance measurement, a performance measure and a performance system are given [5]:

- “Performance measurement can be defined as the process of quantifying the efficiency and effectiveness of action.”
- “A performance measure can be defined as a metric used to quantify the efficiency and/or effectiveness of action.”
- “A performance measurement system can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions.”

This research study is divided into two main parts:
- Theoretical approach – research existing performance evaluation systems and summarize features, advantages and disadvantages of such systems.
- Practical implementation – development of web-based academic staff performance evaluation system for SEE University. The theoretical part has been used for analyzing and gaining knowledge and insights for such systems with accent on finding best practices in developing such systems by summarizing features, advantages, disadvantages and possible issues that may arise while development such types of applications.

Practical part is mainly divided into three development phases:
1. Design and Modelling of the entire solution
2. Database Analysis, Design and Implementation
3. Web Application development

The end result is the implemented software solution at SEE University that serves for academic staff evaluation processes and is easily extensible to become large general performance evaluation application for the entire University.

II. ANALYSES OF EXISTING PERFORMANCE EVALUATION SYSTEMS

Several existing performance evaluation systems and applications has been observed and analyzed. After following the recommendations from [1] and reviewed ten’s of applications programs that are used for performance evaluations, the main observation focus was given to the following four evaluated as currently the best there is in the market:
- ReviewSNAP
- Performance PRO
- Atlas 360
- Bamboo HR

Analyzed and observed performance evaluation application programs have shown multiple common features that exists in each as core functionalities, which other general performance evaluation systems have.

Main common functionalities are:
- 360 Degree feedback
- Development tracking
- Employee Evaluation Forms
- HR Integration
- Multi-Language
- Reporting
- Performance Metrics
- SDK (Software Development Kit)
- Standard Appraisal Forms
- Notification System

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- Custom Rating System

Besides the most common features that exists in each of the observed performance evaluation systems, there are many others which has been developed inside them through different versions and until the product has became mature.

Using automated or partially-automated performance evaluation systems not only helps better organization of data and better way of implementing performance evaluations, but also improves the overall process by giving multiple positive attributes that are important for the information technology era.

Before using performance evaluation programs, organizations have been using a lot of spreadsheets.

Using performance evaluation programs, the HR administrative tasks consume much less time, and the same goes to employees who previously needed to fill some other types of forms and spreadsheets as an input to the whole evaluation process.

“BambooHR is just such an easy application to use. Everything is so clean and simple. Rather than having to pull up four different spreadsheets, all of my info is right there. It was really simple to get started.” Meagen Ridley (Doba) [4]

“BambooHR has consolidated all the work we need to get done. It's so nice to have all the information in a central location, and with the reports we can extract the information so easily - instead of using multiple spreadsheets to track employee records. Everything is so much more organized.” – Tamara Miner (Orange Soda) [4]

“I found ReviewSNAP through an internet search. I needed a tool that could span the diversity of my workforce from novice to expert managers in the administration of performance reviews. ReviewSNAP has been the perfect tool in this facet of organizational change for my company due to the tool itself and due to their understanding of superb customer service.” - Claudia Kropf, Sr. Director of Human Resources. [4]

Partial Performance Evaluation Systems are these which help evaluate only specific area of evaluation; therefore these contain only specific features and functionalities from the general performance evaluation systems. Moreover, partial performance evaluation system can be a system which covers only specific group of employees within the organization.

The main application developed as part of this research study is considered as Partial PE system which will include only specific features to cover specific group (Staff) of employees and help University measure their achievements based on published and approved research papers.

III. CONCEPTUAL DESIGN

The conceptual design and the goal of the developed software solution at SEE University is to serve for academic staff evaluation processes and to be easily extensible to become large general performance evaluation application for the entire University.

When focusing on the performance measurement system design, defining item pools and test items is crucial.

The software has the acronym ASPES that stands for Academic Staff Performance Evaluation System.

ASPES represents a partial performance evaluation system that focuses on accomplishing the process of academic staff evaluation by gathering data through web application.

ASPES is designed for University academic staff and is focused on the university needs to accomplish certain scenarios as part of the academic staff performance evaluation process.

The observing and evaluating performances by measuring quantity and quality is considered important from far away in the past. The main goal for doing it is to evaluate the performance of an individual for something that he has done. This process was simpler in the past, but in present days the same process is more complex because [5] it contains multiple steps and may slightly differ in different organizations and institutions.

The process is important because it helps managers and employees in career development and the same process contains multiple important phases, such as: obtaining, analyzing and recording information for employee’s contribution to the organization. The contribution should be considered as sum of employee successes and failures, personal qualities and other aspects that are relative to the type of organization where employee works.

Performance evaluation in the past was more present in non written way by promoting participants in the groups and teams for their successful achievements, or the opposite [5]. In the past century, performance evaluation is more present at scene on a written formal way by evaluating all the aspects of contribution of an employee to the organization. In the past two decades, Performance Evaluation process is becoming more and more automatic by using technology for automatically gathering and processing data throughout detailed workflows where the end result is information representing the overall contribution of the employee.

Our focus is on the very first measurement, to evaluate [3], which is the most important in order to get the results most appropriately to achieve the rest seven.

![Fig. 1 Performance evaluation system View](image_url)

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**Excellent Performance**

**QUADRANT 4**

“Possible Overkill”

**FAIR PERFORMANCE**

**QUADRANT 3**

“Low Priority”

**Slightly Important**

**QUADRANT 2**

“Keep Up The Good Work”

**Extremely Important**

**QUADRANT 2**

“Concentrate Here”

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According to [2] successful organizations always try to find a better way to improve and enhance the overall quality of the service the organization offers, in which the employee’s contribution could be considered as most important.

For the employee, conducting proper performance evaluation in an organization is very important because it tells employees to focus on their work activities and goals, perform well, and encourage even better performance in the future, so that the whole performance of the organization is overall enhanced [4].

For the organization, performance evaluation helps identify the best contributors to the organization. It examines the strengths and weaknesses of the evaluated employees.

Performance standards must be evaluated to ensure that the work employees have accomplished and the results achieved are aligned with the departmental goals and needs.

When performance is managed effectively and consistently, the organizations function more effectively [5].

IV. METHODOLOGY FOR DEVELOPING PERFORMANCE EVALUATION SYSTEMS

The methodology includes application of MVP, decorator, repository and other structural patterns, structural definition and creation of five-layered application that will follow particular code standards. Application architecture defines the application layers, design patterns used to accomplish different tasks and ways that the problem of developing the application is solved.

There are several design patterns that has been identified as potential to use within the application to create more standards-based code.

ASP.NET MVP Pattern stands for Model View Presenter. The Model View Presenter is very similar to the famous Model View Controller (MVC) pattern. The idea behind MVP pattern is that Model (Data) View (UI) and the Presenter coexists all together in a scenario where Presenter will interacts with the View and will Use the Model to retrieve data from Repository, while the View communicate with Model only for Data Binding purposes. The Presenter has biggest responsibility, which means it determines how data is displayed in the view and performs some more logical operations.

Decorator pattern is useful when we need to wrap another class and add more decorations to it. In practice, it is very useful when you want to extend (decorate) the functionality of a certain object at run-time, independently of the other instances of the same class.

To define interface for creating an object and still let the subclass to decide which class to instantiate is known as Factory pattern. As the name refers, it uses the concept of factories and is very important to avoid some common design problems such as duplicate code, provide better design of object instantiation, etc.

Directly accessing data from business layer to the data source can lead to several known issues:
- Higher potential of errors and bugs
- Duplicate code
- Weak typing of business data
- Impossible to implement unit and other types of testing

To avoid such common problems, we can use the known Repository Pattern.

The aim of Repository Pattern is to provide common way of accessing data, maximize the amount of code that can be tested and isolate data access layer to support unit testing, access data source from many locations, implement centralized data caching mechanism, improve code maintainability, etc.

The developed software solution consists of five main layers:
- Data Access Layer
- Business Layer
- Service Layer
- Presentation Layer
- View Layer

Data Access Layer is the layer with responsibility to...
provide unique access to the repositories. All operations that will work with the repository will have to pass through the Data Access layer.

Business Layer is the application layer that has responsibility to perform business logic and other operations. It is the only layer which interacts directly with Data Access Layer and is bridge between Presentation and Data.

Service Layer is middleware layer which is used to create external application API that will expose certain number of functionalities through services. The layer will communicate with Business layer only. No Data Access layer or any other layers.

Presentation Layer is the controller which will communicate with Business layer and perform few more operations to define how data is represented in the View and help the View remain very simple and easy to maintain.

Since MVP pattern is used, Presentation and View are divided into two different layers. View layer is composed of User Controls and is modular enough so that extensibility is one of the main advantages in this design.

V. DEVELOPMENT AND IMPLEMENTATION

Since this is conceptually a web based application, it’s obvious that there is many technologies used to build and develop the entire application.

Two main researches have been performed:
- User Interface Design, following the recommendation from [3]
- Technology architecture and visualization, following the recommendation from [2]

The user interface design research consists of steps to find current trends in creating user experience and user interface that users can find it intuitive and easy to use [3].

This research consists of few main parts:
- Structuring website layout
- Colour nuances
- UI technologies

architectural design is not broken and can continue further in development.

This graph is very good when there are larger teams working on the project, where in such case, it is very hard to maintain clean architectural dependencies between libraries and layers, thus by using this graph we can confirm that our architecture still follows the rule that the architect has setup.

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VI. RESULTS

Zones of abstraction and instability can show us how much our code is tightly or loosely-coupled. This way, we can visually see whether we have stable assemblies or not. If it goes to the zone of instability, it means it is more stable but lacks abstraction.

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Each participant entered a pre-test and post-test with the objective to be able to assess the increase in their skills caused before and after the use of the software.

The analysis found a positive relationship between the pre-test and the post-Test, \(F(1, 63) = 81.130, p < 0.001\), and there were no significant differences between genders \(F(1, 63) = 3.088, p = 0.084\).

<p>| TABLE I |
| ANOVA RESULTS FOR PRE-TEST BY TRAINING CONDITION AND GENDER AND THEIR INTERACTIONS |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>63.782</td>
<td>1</td>
<td>63.782</td>
<td>1.254</td>
<td>0.237</td>
</tr>
<tr>
<td>Gender</td>
<td>540.588</td>
<td>1</td>
<td>540.588</td>
<td>8.907</td>
<td>0.004</td>
</tr>
<tr>
<td>Group * Gender</td>
<td>57.420</td>
<td>1</td>
<td>57.420</td>
<td>1.019</td>
<td>0.317</td>
</tr>
<tr>
<td>Error</td>
<td>3869.019</td>
<td>33</td>
<td>40.266</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4489.941</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**p<0.01

<p>| TABLE II |
| ANCOVA RESULTS BY GROUP AND GENDER AND THEIR INTERACTIONS FOR POST TEST |
|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>Sum of squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>453.957</td>
<td>1</td>
<td>453.957</td>
<td>16.745</td>
<td>0.000</td>
</tr>
<tr>
<td>Gender</td>
<td>84.911</td>
<td>1</td>
<td>84.911</td>
<td>3.088</td>
<td>0.084</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>2207.208</td>
<td>1</td>
<td>2207.208</td>
<td>81.130</td>
<td>0.000</td>
</tr>
<tr>
<td>Group pre-Test</td>
<td>134.962</td>
<td>1</td>
<td>134.962</td>
<td>5.078</td>
<td>0.028</td>
</tr>
<tr>
<td>Error</td>
<td>1711.647</td>
<td>33</td>
<td>27.169</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>6069.809</td>
<td>37</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<0.05, **p<0.001

VII. CONCLUSION

The research study contributes with the analyses, insights and recommendations as well as with the new proposed methodology for developing performance evaluation systems.

The methodology includes applying different patterns, structural definitions and creating multi-layered application that follows particular code standards defined by the cyclomatic complexity of the code that helps to calculate the total control flows. That is not an easy task, especially if consider the fact of the time needed to develop the application, resources and the amount of work generated.

The focus of this research study was to use the gained theoretical knowledge to apply in practical scenario and build robust, flexible and strong performance evaluation systems that will serve to accomplish specific scenarios in performance evaluation process of Staff members at SEE University and similarly in other universities as well.

The entire design of the system is easily extensible. The database schema is already designed to support extensibility. By completing this workflow and having all other features in hand, ASPES can be counted as fully functional system that will help automatically evaluate staff members based on their submitted research papers.

Data Visualization and Reporting features are additional benefits of ASPES, which can be easily extended and new reports can be added pretty much easily into the existing system.

The end result is the implemented developed software solution at SEE University that serves for academic staff evaluation processes and is easily extensible to become large general performance evaluation application for the entire University.

There are several analyses performed:
- Architectural Visualization
- Dependency Matrix
- Coding Standards
- Coding Approach
- Code Quality
- Other coding metrics

All performed analysis have improved the overall design of the system, application architecture, structure, code quality and application usability from user perspective.

By having such insights can be used for future further development of such systems, that will help companies and organizations automate performance evaluation processes and achieve better results in the overall evaluation process.

REFERENCES


