THE USAGE OF IT PROJECTS EVALUATION METHODS COVERING THE SPECIFICATION OF SOFTWARE PRODUCER’ ACTIVITIES, A CASE STUDY

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K e y w o r d s: projects evaluation methods, Delphi method, UCP method, estimate factors, environmental complexity factors, technical complexity factors, evaluation criteria.

A b s t r a c t

The usage of the evaluation concerning IT projects by software producers constitutes a crucial element of their preparation and realization. From many generally accessible methodologies the authors chose two methods (Delphi and UCP¹) as well as undertook an attempt of analyzing obtained results. Conducted results will support the evaluation of newly realized projects.

The objective is an attempt of comparing the efficiency of selected methods of pricing the software with indicating the areas of their usage as well as factors which influence the realization of those projects.

Introduction

The issue of estimating constitutes a crucial and very arduous stage in the software production cycle. One has to agree with the words of Fred Brooks „In a given post it is very difficult to conduct a definite, convincing and risky defense of estimating which was created as a result of some quantitative analysis, is supported by small amount of data and faces disapproval mainly because of the managers’ intuition”. According to the definition word „to estimate” means „offer something approximately”, „to evaluate”. In IT sector one expects providing exact costs connected with the realization of a particular

¹ Use Case Points (UPC) is a current technique for measuring functionality of a software system.
undertaking. The scope of costs is determined by regular factors such as: particular terms, goals or business obligations. During the years where IT sector was developing many methods of estimating appeared, they are more or less efficient depending on the conditions and resources, experience, specificity of the project have major significance as far as these conditions are concerned. The article is an attempt of comparing the efficiency of selected methods of pricing the software with indicating the areas of their usage as well as factors which influence the realization of those projects. To minimize the risk connected with failure of the project realization the authors suggest using different methods of estimating. For long-term projects they recommend to gather obtained results (results of estimation) each time. It will enable the verification of planned figures with the actual realization as well as conduct analysis to introduce repair actions. The usage of the measure of estimating efficiency (MES), which is to be described below, allows the manager of the project and managers to limit underestimating or overestimating the project.

For many years the authors have been dealing with both theoretical and practical aspects of IT projects. They actively participate in IT undertakings realized for the sake of different economic entities, with special focus on their economic efficiency.

**Selected methods of estimating software**

According to the data published annually in CHAOS Chronicles by the organization The Standish Group International, about 66% of projects from the IT sector realized within the borders of USA ends up with a failure (WINIARSKI 2011). In Poland there is no systematic research in this area due to high costs.

For many years the consequences of accurate and/or faulty decisions have been visible in the economy and described in professional literature. One of the most basic issues in planning IT undertakings is precise determination of their efficiency. On one hand, it is connected with rationalizing the expenses, on the other – with achieving, in proper conditions, optimal appropriable and economic effects (BOEHM 1981, DUDYCZ, DYCZKOWSKA 2006, CEGIELKA, ZALEWSKI 2000). It is worth using the measure of estimating efficiency (MES) for this purpose which is calculated according to the formula:

\[
MES = \left( \frac{CR}{CZ} \right) \cdot 100\%,
\]

where:
CR – number of hours planned for realization in particular period,
CZ – number of hours realized in particular period.
All repair and correction activities connected with selected method and the change of structure (organization) of the company should provide the optimal value of the measure. According to the practice the typical division for the measure MES is: \(<80\%;\quad 120\%\>\). Preventing both underestimating and overestimating enables meeting the project requirements.

The most popular methods of estimating are informal techniques and techniques transferred from classic economy (GÓRSKI 2000). They are, among other things, expert’s opinion, estimating by analogy and estimate models. Each method can be used according to two main rules of estimating bottom-up or top-down. Estimating with bottom-up method starts with the analysis of particular components. They are added up and necessary operations on the sets are done obtaining the total picture of the project. Top-down estimating is a reversed process – it begins with looking at the project in a „bird’s eye” way and particular elements are treated as its components.

The expert’s opinion has been popular for many years as a method of predicting the scope and costs, based on the estimates of individuals who have participated in projects similar to the one they have to analyze (McCONNELL 2006, KACZOROWSKI 2010). However, it is a totally subjective method and not described by any strict algorithm. Nevertheless it provides surprisingly good results (LIPSKA, TAŃSKA 2002, WINIARSKI 2011). It is especially used in case of innovative projects (DĄBROWSKI, SUBIETA 2005) because it does not require (in necessary manner) any quantitative data.

Methods of estimating projects recommended by the authors in regards to projects realized as a part of sustaining the sector system to serve local government units are Usage Case Points Method and Delphi Method.

The first one is UCP method which is a derivative of another known method used for estimating the scope of software, the method of functionality points which is based on screen projects and the architecture of the system. The creator of this method is Gustav Karner (KARNER 1993). He introduced the methodology and defined the importance of environmental factors that specify the complexity of the organization, the technical complexity of factors that specify the technical properties of the product and the actors of the system.

In case of UCP method the architecture and screens were substituted with specificity of requirements in a form of cases of usage. Moreover, there are four categories of parameters taken into consideration (ALBRECHT 1979):

– the factor of environmental complexity which reliable establishment enables the level of organization realizing the project; the more importance the factor has, the more it influences the decrease of work consumption of the undertaking;

– the factor of technical complexity which identification enables establishing the level and difficulty as a part of particular technology; the increase of that factor influences the final increase of work consumption estimation;
– actors, the number of external beings (identifying closer and further surroundings);
– cases of usage (number of functions crucial from the perspective of actors).

In a company dealing with the production of software the following procedure of behavior was worked out.

All 13 factors of technical complexity are assigned to proper numerical value which enables the estimation of technical aspects of the product (Tab. 1).

<table>
<thead>
<tr>
<th>Technical factor</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispersed system</td>
<td>2.0</td>
</tr>
<tr>
<td>Efficiency</td>
<td>1.0</td>
</tr>
<tr>
<td>Efficiency for the final user</td>
<td>1.0</td>
</tr>
<tr>
<td>Complex inner processing</td>
<td>1.0</td>
</tr>
<tr>
<td>RE-usage</td>
<td>1.0</td>
</tr>
<tr>
<td>Ease of installation</td>
<td>0.5</td>
</tr>
<tr>
<td>Ease of usage</td>
<td>0.5</td>
</tr>
<tr>
<td>Mobility</td>
<td>2.0</td>
</tr>
<tr>
<td>Ease of introducing changes</td>
<td>1.0</td>
</tr>
<tr>
<td>Compatibility</td>
<td>1.0</td>
</tr>
<tr>
<td>Special protection</td>
<td>1.0</td>
</tr>
<tr>
<td>Dependency on external libraries</td>
<td>1.0</td>
</tr>
<tr>
<td>Additional training for users</td>
<td>1.0</td>
</tr>
</tbody>
</table>


Moreover, 8 factors of environmental complexity were indicated. All of them were assigned to the value determining their final estimation (Tab. 2).

<table>
<thead>
<tr>
<th>Environmental factors</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of the project</td>
<td>1.5</td>
</tr>
<tr>
<td>Experience in creating application</td>
<td>0.5</td>
</tr>
<tr>
<td>Experience in creating application oriented for the object</td>
<td>1.0</td>
</tr>
<tr>
<td>Skills of main analyst</td>
<td>0.5</td>
</tr>
<tr>
<td>Motivation</td>
<td>1.0</td>
</tr>
<tr>
<td>Stability of requirements</td>
<td>2.0</td>
</tr>
<tr>
<td>Part-time workers</td>
<td>-1.0</td>
</tr>
<tr>
<td>Software language difficulty</td>
<td>-2.0</td>
</tr>
</tbody>
</table>

After determining the environmental and technical factors, one has to evaluate the cases of system usage. The first step involves evaluating the complexity of actors (Simple, Average Complexity, Complex); on its basis one establishes the modulus Unadjusted Use Cases Weight (UUCW). Then the value of actors is established (1, 2, 3), on its basis one creates the value of modulus Unadjusted Actors Weight (UAW). Summing two modulus: UUCW and UAW enables the calculation of Unadjusted Use Case Point (UUCP). The following step of the procedure is multiplying the value of UUCP, by technical (TCF\(^2\)) and environmental (ECF\(^3\)) factors, which enables us calculating points of case usage UCP.

\[
\text{UCP} = \text{UUCP} \cdot \text{TCF} \cdot \text{ECF}
\]

The last stage is changing the points of cases of usage to work consumption expressed in hours per person. To do that UCP is multiplied by the Productivity Factor PF, which value expresses the number of hours per person for one point of the case of usage\(^4\). In calculations the authors decided that the value of 20 working hours is 1 PF.

The second aforementioned method – Delphi Method is based on independent estimating conducted by few experts. However, it requires having qualified specialists in particular field (and access to them) in one’s personnel resources.

Algorithm of Delphi method includes the following steps:

– providing experts with proper materials, documentation and time necessary for becoming familiar with them;
– exchange of opinions on the project, analysis of remarks and comments;
– anonymous estimation of work consumption by each expert;
– working out the results of voting, transferring them to estimate form and preparation of estimate report;
– presenting the evaluation of other experts and average estimation, discussion and renewed analysis of factors influencing the work consumption;
– repetition of all action until obtaining approximate estimates of work consumption by the experts or calculation of average of obtained results. This average should take into consideration the pessimistic evaluation (P) and the optimistic one (O) with the value of 1 as well as average value (A) of 4;

\(^2\) Technical Complexity Factor.

\(^3\) Environmental Complexity Factor.

\(^4\) According to definition the value of 20 working hours is recognized as 1 PF (different sources). The author of the method – Gustaw Karner suggested a predictor PF equal to 20 working hours per one UCP, but it can belong to an interval of 15-38 working hours (Karner 1993).
– final estimating of work consumption (OKP) according to the formula: 
\[(P + 4A + O)/6\].

UCP Method as well as Delphi Method can be used by the managers of short-term and long-term T projects with different scope of influence.

**Criteria of evaluation and results of research**

The authors chose projects to constitute empirical material to verify the reliability of offered methods. For the purpose of analysis they chose projects (Tab. 3) realized as a part of a system to serve local government units PUMA (Start-up Platform for Application Modules). These projects (six projects) were realized in similar time intervals. To estimate six project the same environmental and technical factors were used (UCP Method) as well as the experts with comparable knowledge and experience (Delphi Method). The budget of these project did not exceed 2500 hours. The projects cover different elements of functionality of integrated IT system PUMA, such as new module, functionality or integration with external systems. Table 3 presents eight projects (code and name of the project) which were analyzed.

<table>
<thead>
<tr>
<th>Code of the project</th>
<th>Name of the project</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>Integration with external documentation circulation</td>
</tr>
<tr>
<td>58</td>
<td>Module GODP</td>
</tr>
<tr>
<td>61</td>
<td>Functionality to making functionality available</td>
</tr>
<tr>
<td>63</td>
<td>Reporting for GODP</td>
</tr>
<tr>
<td>64</td>
<td>Adjusting GODP for the Association of Communes</td>
</tr>
<tr>
<td>65</td>
<td>Integration with SIDAS system</td>
</tr>
</tbody>
</table>

Source: authors’ own work.

The results obtained by researching selected projects

<table>
<thead>
<tr>
<th>Code of the project</th>
<th>Delphi method</th>
<th>UCP method</th>
<th>Averaged method</th>
<th>Realized budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>141</td>
<td>261</td>
<td>201</td>
<td>120</td>
</tr>
<tr>
<td>58</td>
<td>2,122</td>
<td>2,103</td>
<td>2,112</td>
<td>2,521</td>
</tr>
<tr>
<td>61</td>
<td>123</td>
<td>164</td>
<td>144</td>
<td>122</td>
</tr>
<tr>
<td>63</td>
<td>1,012</td>
<td>780</td>
<td>896</td>
<td>1,308</td>
</tr>
<tr>
<td>64</td>
<td>616</td>
<td>423</td>
<td>520</td>
<td>584</td>
</tr>
<tr>
<td>65</td>
<td>154</td>
<td>209</td>
<td>181</td>
<td>148</td>
</tr>
</tbody>
</table>

Source: authors’ own work.
Each module was independently estimated using methods: Delphi and UCP (Tab. 4). The estimated budget was presented in operating hours (h). Moreover, the analysis was widened by averaged estimate for the methods above calculated using a Simple method of arithmetic average.

**Discussing the results**

Figures (1–5) present the values of planned and realized estimates for particular projects:

Fig. 1. Integration with external system of document circulation according to Delphi, UPC methods

Estimates conducted using UCP method are almost two times higher in comparison to Delphi method (Fig. 1). What is important, realized budget is 20 working hours lower that estimates done using Delphi method.

Fig. 2. Module GODP according to Delphi and UCP methods
In case of module 58 estimate done by using analyzed methods provided approximate results: 2,122 (Delphi method) and 2,103 (UCP method) whereas the realized budget was lower in 400 working hours (Fig. 2). Specific situation was caused by the change of legal regulations.

Fig. 3. Functionality to making functionality available according to Delphi and UCP methods

Figure 3 illustrates the difference (40 working hours) in estimates done using Delphi method (123) and UPC method (164). At the same time it is worth noticing the lack of difference between Delphi method and realized budget (convergence of results for module 61).

Fig. 4. Reporting for GODP according to Delphi and UCP methods

The collation of selected methods characteristic for module 63 (Fig. 4) illustrates the fact of underestimation of labor consumption both using Delphi method and UCP method. It is 300 working hours.
According to Figure 5 the significant differences in estimates obtained using each method are visible. The calculations done using Delphi method are more approximate to realized budget.

Interesting results were obtained for module 65, especially as in this case the realized budget (148) is lower than the one calculated using Delphi method (154) and UCP method (209). The difference is not significant and in case of the first method it is (6 working hours) and in case of the second one it is (61 working hours).

On the basis of aforementioned data one can ascertain that in case of realization concerning minor projects (budget up to 2,500) the most approximate estimates of projects in relation to their later realization derive from
Delphi method. For all of six projects realized using this method the budgets were approximate to actually realized works.

Analyzing the results obtained using: Delphi and UCP methods one can ascertain for six researched modules:
- Modules 51, 61, 65 present a lower value for Delphi method;
- Module 58 presents results approximate two both methods;
- Modules 63 and 64 are characterized by lower estimate when UPC method is used and higher when Delphi method is used.

Depending on the type and specificity of realized project one can notice that in the case of a project covering the addition in a form of a new module to
PUMA system the estimation prepared by using the method UCP is clearly underrepresented whereas in the case of estimating projects including the integration on system PUMA with external systems of other producers the estimate prepared by using UCP method is clearly inflated.

Summing up aforementioned considerations (Fig. 1–6) one can notice that Delphi method offers better estimates of the projects which are taken into consideration.
Conclusion

Many factors (technical and environmental) influence the change of realization concerning IT projects. The authors undertook an attempt of indicating the most crucial reasons for deviation from assumed estimates during the realization of the analyzed projects mentioned above (Integration with external system of document circulation, GODP Module, Functionality to make functionality available, Reporting for GODP, Adjusting GODP to Association of Communes, Integration with SIDAS system). The basic ones include:

- The changes of legal regulations influencing the scope of project realization;
- Changes of resources realizing particular projects (rotation of employees);
- Lesser knowledge on basis of content and experience in the case of realization of new functionalities different from those used while developing the existing ones;
- Organizational changes (especially changes in management);
- Wide spectrum on basis of content concerning realized projects.

While planning and then realizing IT projects one has to establish the budget. In such a way one estimates both the conditions in which they are to be realized as well as conditions in which the effects of undertaken actions will be possible to observe. The final and detailed evaluation of results will be conducted after the project is finished. In such a way the base which constitutes a compendium of knowledge is created and modified. Future managers may use it while planning new projects.

The authors recommend Delphi method as up till now the knowledge and experience of experts offer the most reliable results. They will continue the research in the area of other aspects of the process of producing software trying to bring together academic knowledge and practical knowledge.

References


