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Example of the Application of the Use of the Case Points Method

This text is the second one of the series of articles concerning projects estimation using the function points method. In the first part entitled: “Theoretical Aspects of Projects Estimation Using the Use Case Points Method" theoretical aspects of the function points method have been presented. Here, an example along with mathematical calculations will be discussed. Whilst in the part three entitled: "Project Estimation Using the Use Case Points Method When Using Enterprise Architect", a practical application of the function points method in Enterprise Architect have been presented.

For the purposes of the presentation of calculations of the estimation we will use an example presenting the system designed to assess the hotel employees in order to improve the quality of their work.

Hotel Manager, basing on the opinions of hotel guests and on the basis of the assessment of how the employees perform their obligations, wants to introduce the system of the so-called rewards and penalties. From time to time e.g. once a week, the work of each employee will be assessed. Assessments are to influence the amount of bonus remuneration. For the conscientious performance of obligations, praises of hotel guests, involvement, etc. the hotel employee may obtain a "plus". On the other hand, for improper performance of the obligations, late-coming, etc., an employee will obtain a "minus". Hotel Manager should have the possibility to add "pluses" and "minuses" for each hotel employee in this system, while the hotel employees should have the possibility to view their assessments and assessments of co-workers. Access to the service is to be possible via web browser from each computer terminal available only at the hotel (only from internal hotel network).

Let's assume also that the hotel manager does not want to order the development of the software to other external company. He knows that the employed computer network administrator is a trained computer scientist and has the knowledge and skills to create such a simple service. However, network administrator has practically no experience in the implementation of IT projects, he only took part in the process of defining the requirements and implementation of the system supporting management of the hotel in which he currently works. Before that, he developed literally a few small commercial applications by himself. He poorly remembers RUP methodology discussed in one of the courses related to the software engineering during his studies. However, he possesses knowledge and skills in using UML language and has professional background related to object-oriented modeling. Owing to his profession, he is also a specialist in the design and management of computer networks and databases.

The hotel manager and network administrator will be the people who are involved in the process of the software development. Director has an idea and vision of the

system designed to assess the employees, while computer network administrator is supposed to develop this system. It is not priority project from the point of view of hotel's operations. Manager and network administrator will pursue tasks related to the development of the system within their working hours. However, routine tasks related to position occupied in the hotel will have a higher priority and tasks related to the development of the system for employees' assessment will be of secondary importance. To sum up, the client and the supplier will be from the same company.

Functionality of the system for the assessment of employees is supposed to include:

- Adding a new employee.
- Adding a new period for which employees will be assessed (month).
- Managing the assessments of employees.
- Providing access to employees' assessments.

The system is supposed to be implemented with the use of PHP, HTML and JavaScript languages, while the database is to be based on MySQL.

Step 1. Classification of use cases

Here we define functional requirements - five use cases. Let's study the fragments of the specification of use cases (basic flow) and identify analytical classes (classes of data layer - entities, layer of services and edge layers - interfaces) which will be used in their implementation.

PU1. Add a new employee

- Actors: Manger, Administrator
- Basic flow:
  - Step 1. Employee's data entry.
  - Step 2. Saving data in the system.
  - Step 3. Confirmation of the completion of transactions.
- Entities' classes:
  - Employee (contains information about employees)
- Other classes (edge and layers of services)
  - I_DodajPracownika (interface for adding a new employee)
  - CTR_DodajPracownika (class supporting data from the interface and saving them in the database)

PU2. Add new period of time

- Actors: Manager
- Basic flow:
  - Step 1. Period data entry
  - Step 2. Saving data in the system.
  - Step 3. Confirmation of the completion of transactions.
- Entities' classes:

    - OkresCzasu (contains information about the period of time in which assessments of an employee are taken into account when calculating the bonus, usually it will be one month - from the first until the last day of a month)
- Other classes (edge and layers of services)
    - I_DodajOkresCzasu (interface for adding a new period of time)
    - CTR_DodajOkresCzasu (class supporting data from the interface and saving them in the database)

PU3. Manage assessments

- Actors: Manager
- Basic flow:
    - Step 1. Selection of the period of time.
    - Step 2. Displaying the list of employees along with their assessments in the edition mode and the possibility of adding a new assessment.
    - Step 3. Saving data in the system.
    - Step 4. Confirmation of the completion of transactions.
- Entities' classes:
    - OkresCzasu (contains information about time periods)
    - Employee (contains information about employees)
    - Evaluation (contains names of assessments)
- Other classes (edge and layers of services)
    - I_ZarzadzajOcenami (interface for edition of data related to evaluations of the employees within single period of time)
    - CTR_ZarzadzajOcenami (class supporting data from of interfaces and recording them in the database)

PU4. Display evaluations

- Actors: Hotel's employee
- Basic flow:
    - Step 1. Selection of the period of time.
    - Step 2. Presentation of list of employees along with their evaluations.
- Entities' classes:
    - OkresCzasu (contains information about time periods)
    - Employee (contains information about employees)
    - Evaluation (contains names of evaluations)
- Other classes (edge and layers of services)
    - I_WyswietlOceny (interface for displayong assessments of employees for the given period of time)
    - CTR_WyswietlOceny (class supporting interface of assessments displaying and appropriate entities' classes)

PU5. Log into the system

- Actors: Hotel's employee, Manager, Administrator
- Basic flow:
  - Step 1. Data verification (user name and password).
  - Step 2. Displaying the interface for functionality selection.
- Entities' classes:
  - Employee (contains information about employees and users of the system)
- Other classes (edge and layers of services)
  - I_Logowanie (interface for entering user name and password)
  - CTR_Logowanie (class supporting data from the interface and comparing them with data in the database)

Now we can classify our use cases. It should be noted that the simplest use cases are PU1, PU2 and PU5. They have simple user's interface (PU1 probably[1] editing fields in which one shall enter names, surnames and positions as well as "Save" button; PU2 probably editing fields in which one shall enter the period of time, commencement and completion date as well as "Save" button; PU5 editing fields for login and password as well as "Log in " button) operate on a single database entity, basic scenarios contain at most three steps and implementation of each of them includes exactly three analytical classes (classes from data, services and presentation layer collectively). Other use cases can be classified to the group of medium use cases since they will possess medium interfaces owing to a greater number of presented data, maybe they do not have many steps in the basic flow but they will operate on three entities' classes and will require implementation of four - five analytical classes.

Table 1. The estimated use cases complexity for the system for the assessment of employees

The complexity of use case	Weight	Number of use cases
Easy	5	3 (PU1, PU2, PU5)
Medium	10	2 (PU3, PU4)
Difficult	15	0

Let's calculate the value of unadjusted use cases weight putting data into the formula:

$$UUCW = \sum_{i=1}^{3} n_i w_i = 3 \cdot 5 + 2 \cdot 10 + 0 \cdot 15 = 35$$

[1] At the stage of estimation it is not required to define user's interfaces and we usually do not have their prototypes. We usually estimate the complexity of the interface on the basis of short description of use case, which in a general manner informs what the given use case performs. Based on this, we estimate quantity of data which we shall introduce or which we will view in the interface - this is the basis for the estimation of the interface complexity.

Step 2. Environmental complexity factors

Let's evaluate the impact of particular environmental complexity factors:

- E1 - Knowledge of methodology, UML language, we shall assume the impact at level 2 owing to the fact that our system administrator poorly remembers (from the times of his studies) the principles of RUP methodology and he participated in the implementation of IT system only once and on the part of customer, however, he has the knowledge and skills in using UML language.
- E2 - Experience of the team, we shall assume the effect at level 3, owing to the fact that the Contractor does not have any big experience in the implementation of IT projects, he participated only in the process of defining requirements and implementation of the system supporting management of the hotel in which he works now, previously he developed literally a few small commercial applications by himself, however, the system will be not complicated and complex.
- E3 - Knowledge of object-oriented techniques, we shall also assume the effect at level 3 because the Contractor has professional background related to object-oriented modeling, however it is not supported by experience or great practice.
- E4 - Skills of the main analyst, we shall assume the effect at level 5 owing to the fact that hotel employees themselves (the client and the supplier at the same time) will be the source of requirements.
- E5 - Motivation of the team, we shall assume the effect at level 3 owing to the fact that despite interest in the project, the tasks related to development of the future system do not have high priority and the whole system is not critical from the point of view of functioning of the hotel.
- E6 - Stability of requirements, we shall assume the effect at level 5 because it shall be an additional system only for the purposes of motivating hotel employees.
- E7 - Participation of part-time employees, we shall also assume an impact at level 5 owing to the fact that director and administrator will pursue tasks related to the development of the system within their working hours. However, routine tasks related to the position occupied in the hotel will have a higher priority and tasks related to the development of the system for employees' assessment will be of secondary importance.
- E8 - Complicated programming languages, we shall assume the impact at level 2 owing to the fact that that the system is to be made in popular programming languages and thus it should not constitute a great problem for an IT specialist.

Table 2. Estimated impact of the environmental complexity factors for the purposes of the system designed to assess the employees

Symbol	Weight	Impact

		evaluation
E1	1,5	2
E2	0,5	3
E3	1	3
E4	0,5	5
E5	1	3
E6	2	5
E7	-1	5
E8	-1	2

Based on this, we will calculate the value of environmental complexity factor putting data into the formula accordingly:

$$ECF = 1{,}4 + \left(-0{,}03 \sum_{i=1}^{8} w_i \cdot impact_i\right)$$
$$= 1{,}4 + \left(-0{,}03 \cdot (1{,}5 \cdot 2 + 0{,}5 \cdot 3 + 1 \cdot 3 + 0{,}5 \cdot 5 + 1 \cdot 3 + 2 \cdot 5 - 1 \cdot 5 - 1 \cdot 2)\right)$$
$$= 1{,}4 + \left(-0{,}03 \cdot (3 + 1{,}5 + 3 + 2{,}5 + 3 + 10 - 5 - 2)\right)$$
$$= 1{,}4 + (-0{,}03 \cdot 16) = 0{,}92$$

Step 3. Technical complexity factors

Let's evaluate the impact of particular technical complexity factors:

- T1 - Distribution of the system, we shall assume the effect at level 0 owing to the fact that we do not need to physically scatter the components of operating system.
- T2 - Efficiency of the system, we shall assume the effect at level 1 owing to the fact that it is not a key factor and essential functions of the system will be used with a small frequency.
- T3 - Efficiency for the final user, we shall assume the impact at level 2 owing to the fact that we do not require specific dispositions from user here.
- T4 - Complex internal processing, we shall assume the impact at level 2 owing to the fact that we will not use complex algorithms or processing.
- T5 - Re-usability, we shall assume the impact also at level 0 owing to the fact that system designed to assess employees is not large and does not contain similar elements.
- T6 - Ease of installation, we shall assume the effect at level 3 owing to the fact that person's - administrator's knowledge who will install the future system on the server will be required.
- T7 - Ease of use, we shall assume the impact also at level 3 owing to the fact that operations associated with interaction with the system shall not be complex, also a great effort connected with development of concept of screens will not be required here.

- T8 - Portability, we shall assume the effect at level 0 owing to the fact that the system is supposed to operate on one, indicated platform.
- T9 - Ease of introducing changes, we shall assume the effect at level 2 owing to the fact that it is unlikely that the system will be further developed in the future and expanded with new functionality.
- T10 - Concurrency, we shall assume the effect at level 0 owing to the fact that the concurrent data processing is not required, while support for many users at one time will be supported owing to the applied architecture.
- T11 - Special access security mechanisms, we shall assume the effect at level 4 owing to the fact that interested and authorized persons shall have the access to the system. Hotel Manager should have the possibility to add "pluses" and "minuses" for each hotel employee in this system, while hotel employees should be only able to view their assessments and assessments of co-workers. Access to the service is to be possible via web browser from each computer terminal available only at the hotel (only from internal hotel network).
- T12 - Providing access for external users, we shall assume the effect at level 0 owing to the fact that other external systems will not use this system.
- T13 - Additional trainings for users, we shall assume the effect at level 0 owing to the fact that the system will be not complicated and will provide several simple functions.

Table 3. Estimated impact of the technical complexity factors for the system for the assessment of employees

Symbol	Weight	Impact evaluation
T1	2	0
T2	1	1
T3	1	2
T4	1	2
T5	1	3
T6	0,5	3
T7	0,5	5
T8	2	0
T9	1	4
T10	1	0
T11	1	4
T12	1	0
T13	1	0

Based on this, we will calculate the value of technical complexity factor, TCF putting data into the formula accordingly:

$$TCF = 0{,}6 + \left(0{,}01 \sum_{i=1}^{13} w_i \cdot impact_i\right)$$
$$= 0{,}6 + \left(0{,}01 \cdot (1 \cdot 1 + 1 \cdot 2 + 1 \cdot 2 + 1 \cdot 3 + 0{,}5 \cdot 3 + 0{,}5 \cdot 5 + 1 \cdot 4 + 1 \cdot 4)\right)$$
$$= 0{,}6 + \left(0{,}01 \cdot (1 + 2 + 2 + 3 + 1{,}5 + 2{,}5 + 4 + 4)\right) = 0{,}6 + 0{,}01 \cdot 20$$
$$= 0{,}8$$

Step 3. Classification of actors

It is time to classify future actors of the system. From preliminary requirements it results that we will have three actors, respectively: the hotel manager, system administrator and the hotel employee. The most general actor will be the hotel employee, his or her role may be also assumed by the hotel manager and system administrator. It turns out that all actors shall be classified to the group of complex actors, since actors represent roles of a person who will communicate with the system for the assessment of employees via graphical interface.

Table 4. the estimated actors complexity in the system for assessment of an employee

The actor complexity	Weight	Number of actors,
Easy	1	0
Medium	2	0
Difficult	3	3 (the hotel employee hotel, director and system administrator)

On the basis of estimated actors complexity, we calculate unadjusted actors weight , UAW putting data into the formula accordingly:

$$UAW = \sum_{i=1}^{3} n_i w_i = 3 \cdot 3 = 9$$

Step 4. Calculation of use case points

Before we calculate use case points UCP, we will have to determine unadjusted use case points UUCP, we remember that values of unadjusted actors weights UAW and unadjusted use cases weights will be necessary here:

$$UUCP = UAW + UUCW = 9 + 35 = 44$$

Only now we use the formula with the use of which we calculate use case points UCP of particular interest for us, we remember that it uses just calculated unadjusted use case points UUCP and previously designated values of technical complexity factor TCF and environmental complexity factor ECF:

$$UCP = UUCP \cdot TCF \cdot ECF = 44 \cdot 0{,}8 \cdot 0{,}92 = 32{,}384 \approx 32$$

From the practical point of view it is not required to use great precision of the obtained results since these are only attempts to evaluate some values basing on coarse classification and evaluation of relevant factors having effect on the final value of work effort.

Step 5. Determination of work effort

It is time for the determination of work effort of the development of the system for the assessment of employees. If now we assume typical value proposed by Gustav Karner equal to 20 UCP per 1 man-hour for the productivity factor PF, estimated work effort will amount to:

$$UCP \cdot PF = 32 \cdot 20 = 640\ man - hours.$$

This means that, with the above specified requirements, one person will be able to create system for assessment of employees in the period of 640 working hours. By analogy, two persons would work on the development of this system for the period of 320 hours. If we assume hour rate connected with remuneration for solving the problem for the client (hotel manager) e.g. at the level of 40 USD/h of work now, the total price for the development of the system would amount to:

$$640\ hours \cdot 40\ USD/h = 25600\ USD$$

Summary

In this the text we have presented, basing on the knowledge presented in the first article, the process of the estimation of the system for hotel employee's assessment in order to improve the quality of their work. The above calculations are quite laborious, especially in case of larger systems. For this reason, it is worth to use Enterprise Architect for the purposes of this type of estimation and it has been presented in the article, "Project Estimation Using the Use Case Points method in Enterprise Architect".