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ORTHOGONALITY MEASUREMENT FOR HOMOGENOUS PROJECTS-BASES

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Abstract: *The homogenous projects-base concept is defined. Next, the necessary steps to create a homogenous projects-base are presented. A metric system is built, which then will be used for analyzing projects. The indicators which are meaningful for analyzing a homogenous projects-base are selected. The given hypothesis is experimentally verified. The projects are analyzed and measured to establish the quality level of the funds spending. Some examples of measurement are offered in this paper. The most important characteristics of the projects are identified and presented. Also, a quality characteristic framework of homogenous projects is provided by this paper. The framework is used to develop metrics that cover the properties and requirement of the projects. The implementation of the project characteristics is made within a software application, called Projects-Bases Operations Software (PBOS).*

Key words: *orthogonality analysis; quality; projects-base; homogeneity; metric*

1. Homogenous Projects-Base

The most spread definition of a project is that of a temporary endeavor undertaken in order to create a unique product, service or result. No matter their type and structure, projects can be grouped based on different criteria. A grouping can be called a program, a portfolio or simply a collection, based on the ownership of the projects contained, based on the project goals and on the project types. We a call a portfolio of projects a set of projects, not necessarily inter-dependent, which are performed by a project-oriented company at a certain point in time. If the projects are inter-dependent and strategically they are perceived as an ongoing long term correlated effort, then we are talking about a program. If the projects analyzed don't fall within the definition of portfolio or program then they can simply be referred as a collection of projects.

According to the Romanian Explicatory Dictionary (DEX), homogeneity is "the attribute of an object or a group or a physical-chemical system of having the same characteristics allover".

From a statistical point of view, homogeneity of data means:

- collecting data from homogenous statistical entities;
- fall within the same definitions and methodologies of calculation in relation to the scope of time and space;
- description of evolution of status within a timeframe which is not subject to major modifications of the analyzed process;
- refers variables by using the same measure of unit – this is most commonly used when evaluating economical indicators in real or comparable prices.

Empirically speaking, if we have a collectivity identified by a characteristics which falls within the interval (a, b) and which has an average X^{MED}, it is said that the elements of that collectivity form a homogenous collectivity if $a = X^{MED} - 2.5\% * X^{MED}$ and $b = X^{MED} + 2.5\% * X^{MED}$.

The above result is the output of analyzing the input of 300 specialists facing the challenge of determining the needed heights of people from a team, so that the team would be considered homogenous. By analyzing the data sets there was obtained the lower limit, the upper limit and the average height. Statistical analysis showed the results are stable and representative. The length of the interval equals 5 % of the average height value.

Coming back to projects-bases, homogeneity is built following those steps:

- a program with clear objectives is defined;
- guidelines for drawing the projects are presented;
- the guidelines used for assessing the projects are presented;
- the templates to be used for detailing the project and structuring the budget are given;
- there is a given key words list;
- there are a given certain thresholds for texts and different thresholds for budget figures.

There are projects-bases for different industries and different purposes within those industries, like projects-bases for building hospitals, research for environment protection, putting up education centers around the country and so forth. They are all influenced and diverse due to the experience of the people who propose the projects, due to the proposed

objective, due to the resources used for implementation, due to techniques used and so forth.

The main goal is that those projects increase homogeneity so that the projects have a better chance of getting to implementation, of delivering quality as well as being considered a success.

On existing projects-bases there have to be analyzed the projects and to be identified and diminished the causes that lead to lack of homogeneity.

2. Milestones for Building Homogenous Projects-Base

In order to build strong project proposals, there must be put in place a strategy for deploying the processes of creating, evaluating, financing, implementing and auditing the projects, so that the projects will address a high level of quality:

- define the financing purpose – the objective must be clearly stated and must targeted to be achieved only by skilled professionals;
- define the eligibility criteria – there must be strict criteria in place, including years of experience, relevance of previous projects, clearly defined contribution;
- creating a guide for creating project proposals – clear guidelines using precise terminology and references which can only be accessible and understood by true professionals;
- creating the evaluation booklet and a full process for handling the evaluation – put in place clear evaluation criteria and detail on every step of the evaluation and even focus on appeals that may arise after the evaluation ends;
- put in place clear quality thresholds as related to management, documentation, guidelines – projects that do not comply with at least one of the thresholds are automatically disqualified;
- the scoring has to be representative enough for the overall quality of each project, as for small differences between projects to be sufficient to distinguish between a selected and a non-selected project;
- during the lifecycle of the project there has to be taken into account not to be major differences between what has been planned and what has been delivered;
- auditing has to establish that what has been delivered is in line with expectations;
- nevertheless – the satisfaction degree of end users for all homogenous applications has to be at the same level.

The main target beneath the homogeneity concept is that of identifying different ways of reaching the highest quality level possible.

3. Set of Indicators to Be Used for Analyzing Quality of Projects

Projects should all encompass the following quality characteristics: gradualness, complexity, orthogonality, correctness, completeness.

Gradualness is a quality characteristic that refers to the degree by which the project has been addressed following a waterfall like approach. Therefore, it is of interest the degree by which the project title is connected with the project abstract, the degree to which the project abstract is connected with the introduction, and so forth. An indicator, having

values in the range 0 to 1 will show the degree of logical coherence of the project flow, 0 showing a total lack of gradualness, whereas 1 will show a gradualness which is fully implemented.

Project *complexity* is the universal measuring unit for all the projects. Complexity represents a characteristic, which is common to all the projects. Projects differentiate through the complexity degree. Some projects are simple. Others are complex. The resources asked by a project vary very much, depending on its complexity. Thus, a project could be realized in a few weeks or it can last more months; a project may need from one team with few people to teams with hundreds.

Orthogonality means determining the degree to which two text entities are different, considering their presentation means and content. Two projects will be considered orthogonal if their texts only have in common the domain specific technical terms, whereas the others words differ in terms of frequency and positioning within the sentences. It is more important that projects texts are orthogonal and not completely different, because very different texts could mean that the two projects do not belong to the same domain.

Correctness as applicable to projects means that the project text is accepted as being in accordance with the base requirements for the domain that is being financed. Correctness envisages to the naming of processes, technologies and operations, the usage of appropriate concepts, models and the usage of proper variables. Therefore, by respecting the industry standards and code of professional ethics all that previously existed has to be correctly cited and referenced in the bibliography. Correctness also refers to the logic behind activities planning, resource consumption and estimating. If project valuation procedure is transparent, correctness means that auto valuation differs very little from the official valuation.

Completeness is the project quality characteristic that shows the degree by which, when turning project plan into action, the desired project outcomes are obtained. The level of completeness is to be considered one if supplementary costs are not present. The more the completeness level is closer to zero, the more it is clear that the project responsible for project delivery has not taken into account some activities, has badly estimated durations or has not properly managed the deliverables dependencies.

The indicators to be used on testing homogenous projects, depicted in figure 1, need to fulfill a series of conditions and must possess some properties as follows:

- sensitivity – the slightest variations of exogenous variables will produce slight variations for the indicator itself;
- non-catastrophic – there will not be scenarios when, for small variations of exogenous variables, we will have large variations of the indicator;
- non-compensatory – for different levels of independent exogenous variables there are obtained different values of the indicator;
- representativeness –there is defined a clear correspondence between intervals of possible value of the indicator and qualitative levels of the process;
- efficacy – the level of correlation between the effort of reaching a certain level for exogenous variables and the effects generated by the decisions taken upon the level of the indicators.

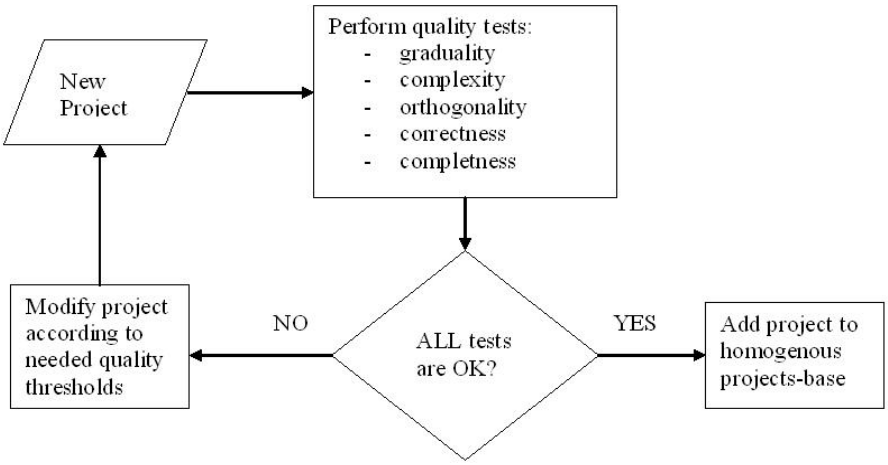

Figure 1. Quality characteristics of homogenous projects

In (Romulus Arhire, 2000), it is demonstrated that an aggregated indicator cannot have three characteristics at the same time: sensitivity, stability and non-compensation. For avoiding the appearance of the compensatory effect, which is specific to aggregated indicators when making a hierarchy based on several complexity characteristics, it is used the grouping technique called *cluster*.

4. Homogenous Projects-Bases Metrics

Homogenous projects-bases have several things in common, like:

- the texts do not differ significantly in terms of length;
- common vocabularies;
- frequency level differences;
- close complexity levels;
- common citations.

The system of indicators specific to homogenous projects-bases includes components that allow differentiations even within very narrow intervals. Therefore, there are taken into account the indicators presented in the previous chapter.

Every indicator is defined, the influence factors are presented and it is demonstrated that at very small variations of the involved factors, there are obtained large variations of the indicators, therefore making those indicators representative for homogenous projects. Those indicators allow the grouping of homogenous projects in project classes, therefore having an even higher degree of homogeneity and the quality will be closer to the desired maximum level.

Homogenous projects involved in obtaining financing are built following clear guidance, which comprises of:

- vocabulary, with key words;
- structure based on chapters;
- structure of tables to be used for presenting the numerical information;
- calculation algorithms;
- maximum lengths of texts;
- verification keys;
- restrictions regarding the thresholds for eligible spending.

If the project proposal is done in an assisted approach, the requestor is not allowed to move to the next step if he has not satisfied the guidelines imposed by the financer. If we have a threshold of maximum 500k EUR of financing for a project and the applicant is requesting 600k, the request will not be processed and if the requester insists for more than 5 times without taking into account the imposed limitations, then the application will reject the input and the project data will be removed completely.

Quality of homogenous projects possesses a characteristic called *gradualness*.

The project text is composed of C1- title, C2 – abstract, C3 – objectives, sub objectives, …, Cn – audit. The project proposal owner creates first C1. Starting from C1, he creates C2, then C3, by following a water flow approach. The indicator has to determine the degree to which C1 is included in C2, C2 is included in C3 and so on. The indicator will tend to be zero if the vocabularies are almost disjunctive and will tend to be 1 as long as most of the words of C1 are found in C2 vocabulary, most of the words of C2 are found in C3 vocabulary and so on.

$$GRD = \frac{\sum_{i=1}^{M-1} \frac{(card(Ci \cap Ci+1))}{card(Ci)}}{M-1}$$

where:

- Ci – set of distinct words from chapter i;
- M – maximum number of words;
- card(*arg*) – total number of words from a given collection.

One approach to measuring *complexity* is that of taking into account the variety of existing resource types and their quantities.

$$C = \sum_{i=1}^{m} q_i * \log_2 q_i$$

where:

- C – project complexity;
- m – total number of distinct resources used by the project;
- q_i – quantity of the resource with index i.

A very simple implementation of such an indicator for *orthogonality* would be, (Andrei Sandu, 2008):

$$ORTO = \frac{NW_{both}}{NW_{\max}}$$

where:

- NR_{both} – total number of words, which are part of the project domain standard terminology, which are found in both texts analyzed;
- NR_{max} – the highest of the total number of domain specific words of the two projects.

Therefore, for this indicator a value of 1 means the two projects are cloned one after the other, whereas a value of 0 means that the two projects are orthogonal.

Correctness envisages things like using preexisting knowledge, formulas without altering the initial contents, putting a certain professional order in the operations undertaken, in applying procedures and processes as to demonstrate that the project proposal owner is experienced within his competency.

In case of partial valuation, (Nicolae Enescu, 2008), it is needed to determine the weight of correct criteria from the whole set of criteria.

The relative correctness indicator, RCI, is computed as follows:

$$RCI = \frac{\sum_{i=1}^{n} R_{ia}}{\sum_{i=1}^{n} R_{iMax}} * w$$

where:

- R_{ia} – actual result of valuation, based on criterion i;
- R_{iMax} – maximum result of valuation, based on criterion i;
- w – weight of correct criteria from the whole set of criteria.

There are three matrixes to be considered as relevant in project *completeness* valuation:

- A-C matrix – shows all resources used for performing each activity;
- A-TM matrix – shows the allocation of project team members on activities
- A-A matrix – shows the dependencies between the activities.

One indicator of completeness, CMPL, has the following form:

$$CMPL = \frac{3 - \frac{\Delta_1 + \Delta_2 + \Delta_3}{n}}{3}$$

where:

- n – number of project planned activities;
- Δ_1 – number of activities which have at least one difference between the planed and the executed A-C matrix;
- Δ_2 – similar to Δ_1, except it applies for A-TM matrix;
- Δ_3 – similar to Δ_1, except it applies for A-A matrix.

According to the guide for project proposals, there is imposed a certain structure and a project will be considered incomplete if any of the following is true:

- missing chapters;
- missing activities;
- missing links between activities;
- missing formulas.

Therefore, a simple indicator stating:

(total expected item – missing items) / total expected items

will show the level of completeness for any of the above stated criteria. A value of 1 will be interpreted as complete project, whereas any value < 1 will be considered as incomplete and the project will be considered for rejection or additional information will be asked for.

The implementation of the above-mentioned indicators is done within PBOS application, in dedicated procedures named accordingly – *computeGraduality, computeComplexity, computeOrthogonality, computesCorrectnes, computeCompleteness*.

5. Experimental Results

It is considered the objective of evaluating the projects sent by students at a master in project management and grading them accordingly. Around 100 distinct projects have been received. They have all been sent via e-mail for being evaluated. The format of sending consists in both a Word document with the whole project description as well as a collection of text documents that are in fact the chapters of each project.

The sample of projects is considered representative for the purpose of our study of homogeneity because all students who submitted the project proposals have taken part at the same classroom where they where explained the purpose of the projects, the structure, information formatting and the marking criteria. Also, they are all using the same terminology in terms of quality management and project management, as presented during the classroom hours.

The imposed project structure is as follows: title, abstract, introduction, presented problem, proposed solution, results, analysis, conclusions, bibliography and annexes.

The reason for sending distinct text files resides in the fact that they are all used as input in the PBOS application for performing the operations for testing homogeneity and nevertheless for grading the projects of the students.

After having input all the data in the application there was tested the orthogonality of each project text in relation with the text of all other projects in the projects-base. The result is as depicted in table 1.

Table 1. Computation of orthogonality each 2 by 2 projects

Project ID	Project Name	Project ID	Project Name	Orthogonality
1	GISG	2	OCMC	0.76
1	GISG	3	SDDE	0.95
1	GISG	4	DIII	0.88
...				
42	MIC	1	GISG	0.92
42	MIC	2	OCMC	0.87
42	MIC	3	SDDE	0.70
...				
104	TVD	101	OIIL	0.83
104	TVD	102	MMAR	0.77
104	TVD	103	SVIC	0.74

Next, for each project there has been computed an average orthogonality and a completeness value as well, by taking into account if all chapters have been sent for the projects. Based on the average orthogonality and the completeness indicator, there is establishes a ranking, as average between the previously mentioned two indicators, as depicted in table 2.

Table 2. Ranking based on avg. orthogonality & completeness

Project ID	Avg. Orthogonality	Completeness	Ranking
1	0.93	1	0.9650
68	0.85	1	0.9250
76	0.83	1	0.9150
...			
98	0.75	0.9	0.8250
15	0.64	1	0.8200
30	0.63	1	0.8150
...			
56	0.62	0.8	0.7100
94	0.59	0.8	0.6950
86	0.65	0.7	0.6750

The results are now converted into marks. Therefore, we obtain a summary that looks as depicted in table 3.

Table 3. Summary of marks

Mark	Percentages
7	8.42 %
8	57.89 %
9	32.63 %
10	1.05 %

The table above is a clear indication that the efforts to create a homogenous project-base have succeeded, in the sense that the level of quality for the projects comprised is very similar. In order to minimize the impact of projects that obtain a lower mark, for example mark 7, and therefore decrease the level of homogeneity a stricter filter has to be put in place when accepting projects. One should reject projects which have an average orthogonality < 0.7 or a completeness indicator < 0.8.

6. Conclusions

The main goal for homogenous projects-bases is that of wisely spending the total funding capacity. Therefore working with homogenous projects-bases is similar to an active attempt of moving quality towards the upper bounds in all involved stages.

The financing programs become clear if:

- they are defined completely and they contain procedures and clear documentation;
- the teams who made the project proposals are trained in drafting high quality proposal and are helped in implementing the projects afterwards;
- there is a process of creating a hierarchy of project offers, so that the risk of having differences between the project proposal – costs, durations, fulfillment degree and so forth – and the effective project roll-of is minimal.

In project management, the efficiency of financing is given by:

- full utilization of resources;

- not over passing the planned financing threshold;
- keeping any supplementary spending within reasonable limits, which do not affect the overall estimated level.

In order to assure a homogenous projects-base creation, different indicators, like gradualness, complexity, orthogonality, correctness and completeness can be applied to projects that are enrolled for obtaining financing. The resulted projects-base allows this way the extraction of information on the long run in relation to teams, projects that have been proposed and implemented, as well as qualifications obtained for those projects.

One simple way of increasing the homogeneity of a projects-base is by modifying its acceptance levels for the metrics used on projects proposals. Like in the given example, an average orthogonality < 0.7 or a completeness indicator < 0.8 will increase the chances of having only good projects in the projects-base – to be marked 8, 9 or even 10.

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He has participated in the scientific committee of more than 20 Conferences on Informatics and he has coordinated the appearance of 3 proceedings volumes for International Conferences. From 1994 he is PhD coordinator in the field of Economic Informatics.

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His main interest fields are: software metrics, optimization of informatics applications, developments and assessment of the text entities, efficiency implementation analysis of the ethical codes in informatics field, software quality management, data quality management and so forth.

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He was involved as project manager or research team member in research projects on following topics: virtual intelligent manufacturing processes, developing and testing an automated system of risk analysis, diagnosis and decision to support the medical act, system of quality assessment services generated by mobile applications in electronic business, system of quality assessment for on-line public services for citizens and businesses, system of indicators for evaluating IT project management, collaborative informatics systems in the global economy, methodology of applications development for managing the IT project portfolios, evaluation system of the entities based on text, models to estimate the cost of e-business applications, model base for software quality management, designing and implementing the virtual enterprise and platform for estimating costs of testing object oriented software prototypes.

Currently, he is involved as project manager in a research project on topic Implementation of the Quantitative Methods in Distributed Informatics System Audit and as research team member in techniques for classification and recognition with applications in identification documents similarity.

He is certified as project manager IPMA Level D, Certified Project Management Associate. Also, he holds more awards and diplomas for his research activity.

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