OPTIMISING PROCESSES OF IT ORGANISATION THROUGH SOFTWARE PRODUCTS' CONFIGURATION MANAGEMENT

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Abstract:
The present paper is focused on the efficiency of processes within IT firms which design software products, by finding optimum management solutions for these types of activities. In order to achieve this, we focus on software products configuration management, with specific objectives in documenting and ensuring visibility to the product's configuration and of the stage of achieving its physical and functional characteristics. Through configuration management, technical and administrative rules are established and applied for designing, developing, producing and supporting the elements of the product's configuration, in each stage of its lifecycle. The conclusions of this research are focused on evaluating economic effects obtained by implementing the quality management system, according to the ISO 9001:2000 quality standard, while developing software products, at the level of IT firm.

Keywords: configuration management, quality management, product lifecycle, software quality

Introduction

The traditional software configuration management process is looked upon as the best solution to handling changes in software projects. It identifies the functional and physical attributes of software at various points in time, and performs systematic control of changes to the identified attributes for the purpose of maintaining software integrity and traceability throughout the software development life cycle.

The software configuration management process further defines the need to trace changes, and the ability to verify that the final delivered software has all of the planned enhancements that are supposed to be included in the release. It identifies four procedures that must be defined for each software project to ensure that a sound software configuration management process is implemented. They are:

- Configuration identification
- Configuration control
- Configuration status accounting
- Configuration audits

These terms and definitions change from standard to standard, but are essentially the same.

- Configuration identification is the process of identifying the attributes that define every aspect of a configuration item. A configuration item is a product (hardware and/or software) that has an end-user purpose. These attributes are recorded in configuration documentation and baselined. Baselining an attribute forces formal configuration change control processes to be effected in the event that these attributes are changed.
- Configuration change control is a set of processes and approval stages required to change a configuration

item's attributes and to re-baseline them.

- Configuration status accounting is the ability to record and report on the configuration baselines associated with each configuration item at any moment of time.
- Configuration audits are broken into functional and physical configuration audits. They occur either at delivery or at the moment of effecting the change. A functional configuration audit ensures that functional and performance attributes of a configuration item are achieved, while a physical configuration audit ensures that a configuration item is installed in accordance with the requirements of its detailed design documentation.

Through configuration management, technical and administrative rules are established and applied for designing, developing, producing and supporting the elements of the product's configuration, in each stage of its lifecycle.

The main objective of configuration management is represented by documenting and ensuring the visibility of the product's configuration and of the stage of accomplishing its physical and functional characteristics. Another objective is that there is a complete and proper documentation of the product at any moment of the product's lifecycle

Configuration management implies taking into consideration the following integrated activities: configuration identification, configuration control, evaluating the configuration stage and configuration auditing.

Identifying the configuration of IT products

Identifying the configuration implies the following stages:

- Defining the product's structure and selecting the configuration elements;
- Creating the documentation referring to the configuration elements;
- Establishing some conventions referring to encoding;
- Establishing the basic configuration of the product.

a) Defining the product's structure and selecting the elements of the configuration.

Defining the product's structure must be achieved so as to ensure the description of the relationship and the position of the configuration elements. These elements are selected through a process of dividing the product in components, structured in a logical manner.

Selecting the configuration elements with special importance must start in the preliminary stage of the product (for example, the stages of feasibility and definition of the product). The other element of the configuration of lesser importance will be selected in the early stages of the product's development.

In the selection process for the configuration's elements, the following aspects are taken into consideration:

- Selecting a too great number of elements affects the possibility of visualising the product, thus leading to difficulties in the configuration management and cost increase;
- Selecting a too small number of elements or insufficiently detailed generates logistic and maintenance difficulties and limits the management possibilities of the configuration.

Selecting those elements whose functional and physical characteristics can be directed separately in order to maximise final performance in using each element is recommended.

Other criteria to be taken into consideration in selecting the configuration's elements are the following: criticity in terms such as risks, security, mission success etc.; existing technology, new or modified projects development; interfaces with other elements; supply conditions, logistic and maintenance aspects.

b) Creating the documentation referring to the configuration elements.

All physical and functional characteristics necessary to define an element of the configuration, in each stage of the product's lifecycle, must be documented. Documentation includes specifications, design documentation, software and operation and maintenance manual.

The requested documentation for an element of the configuration depends on the level of control necessary. Documentation must include modifications, derogations before and after the product's completion and information referring to the product's traceability.

c) Establishing conventions referring to encoding

Conventions referring to encoding must be established and applied to identify the elements of the configuration, the documentation, modifications, both for its components and for subassemblies and the finite product.

Conventions referring to encoding must allow:

- management of hierarchic relations between the configuration elements, within the product's structure;
- management of hierarchic relations between components and ensembles of each element of the configuration;
- management of the relations between documents and elements of the configuration;
- management of the relations between documents and modifications operated regarding the elements of the configuration;
- answering other demands regarding the elements of the configuration.

d) establishing the basic configuration of the product

The basic configuration must establish through an official agreement, at a specified moment, serving as starting point for the official control of the configuration.

The basic configuration refers to all the approved documents which define the product at a certain moment.

The basic configuration should be established every time it is necessary, in order to define a referential configuration in the stages of the product's lifecycle, serving as starting point for future activities.

Controlling IT software products configuration

Configuration control refers to activities necessary to control the modifications of an element of the configuration after officially establishing the configuration documents. Configuration control includes evaluating, coordinating, approving and implementing modifications (Futrell et al., 2002).

Configuration control implies undergoing the following activities:

- documenting and justifying the modification which can be initiated by the organisation or by the client or subcontractor.
- evaluating the consequences of the modification, and taking into consideration the following aspects, according to the product's complexity:
  - o technical advantages of the proposed modification;
  - o impact on interchangeability, interferences and identification necessities;
  - o impact on cost and answering contractual time periods;
  - o impact on supplying and stock;
  - o impact on maintenance, documentation accompanying the product and exchange parts.
- Approving modifications by the product manager or by a person delegated by the former. The decision to approve the modification is documented and registered;
- Implementing and checking modifications approved following the following stages:

o Initiating actions necessary in the involved departments;

o Checking conformity in design, product accomplishment, trial etc.;

- deviations' treatment before and after the product's development.

Evaluating the configuration stage is a systematic examination of the results of the configuration management activities to establish the achievement level of the initial objectives.

The correct evaluation of the configuration stage is conditioned by performing proper control of configuration identification and modification.

Identifying the configuration is ensured by proper record logs, starting with the moment of creating the configuration documents and so on, throughout the product's lifecycle. The data is recorded so as to encompass the cross-references and inter-relations necessary to creating the requested reports. The next types of data are recorded: identification data (the number of the component, the document number, edition/revision, serial number), title and data; the stage of issuing and transmitting documents, derogation before and after fabrication; the basic configuration and configuration elements (Berczuk, 2003).

The results of the evaluations are written down in various reports, created at determined intervals.

Configuration audit represents an official examination with the aim of determining if a configuration element is conform with the configuration documents.

Configuration audit must be performed only once for each basic configuration and consists of two stages: functional configuration audit and physical configuration audit.

Configuration audits are performed in order to check if the configuration management is efficient and answers the specific requirements and to determine conformity to management practices of the configuration with procedures described in the plan referring to these activities.

Supervising and permanently adapting processes

a) Supervising priority processes

After the leading management of the IT organisation has determined the priority processes, has established responsible people for processes and performance objectives, the supervising of priority processes must become the focal point. Thus, the leading management must monitor the priority processes' performance, support necessary interventions on ongoing processes and analyse the results obtained. These activities cannot be delegated.

b) Adapting oraganisatory structures

While practices for processes management and performance improvement are ever more evident, it is necessary that organisation structures and responsibilities should be adapted to the new conditions. This is not possible without the direct support of the leading management.

Processes monitoring and improvement

Without permanent monitoring and improvement of processes performance, an appropriate control over them and cannot be achieved, and without management appropriate to the process, process improvement cannot be supported.

a) Monitoring process performance

The person responsible for the process monitors and evaluates systematically the process's performance. In the beginning, a few performance metrics can be used, even if they are not the most adequate, since improvement cycles will correct these deficiencies in time.

b) Determining improvement necessities

Improvement necessities are determined based on the processes' relevance, performance and maturity. For example, if the process is immature, estimating maturity will play an important role in determining improvement, while performance metrics are to be used on a smaller scale.

c) Launching and leading improvement activities

The person responsible for the process must select and decide on improvement actions for improving performance, based on the business priorities and the performance levels of the involved processes. He must always evaluate the improvement resulting from these actions by analysing the data obtained after measuring performance and rank results based on the obtained maturity levels.

Improvement strategy selection for each situation is an important decision, which must take into consideration both the desired improvement degree and the process performance level. Generally speaking, there are three categories of actions that can be taken into consideration for improving performance.

- **actions for problem solving**: their purpose is solving operational problems. They are also applied in the early stages of maturity in order to identify and remove the causes of process instability. In itself, problem solving does not represent a strategy for product capability improvement.
- **action for continual improvement of the process**: their purpose is developing process capabilities. They must be performed when immediate improvement necessities are insignificant and risk must be avoided. In this situation, accent is placed on analysing data referring to the process and on generating and evaluating improvement. Usual improvement techniques include reducing variation, reducing time cycle, eliminating loss, etc.
- **process innovation actions**: they must be performed for large scale improvement. The risks and efforts associated to innovation are greater than in the case of continual improvement. Re-designing the process and organisation re-engineering are the main techniques used in this case, both of them focusing on performance improvement.

Figure 1 presents a few proposals for process improvement associating improvements strategies and instruments to maturity levels of the processes. As it results from the image, passing from a level to another needs specific strategies.

d) Recognising and generalizing improvement application

Improvements must be recognised and generalised applied to fulfil the entire potential of them.

Such an attempt implies a complete action plan appropriately executed, a data collecting and evaluation system referring to results, evaluation necessity and result analysis.

All the three elements are essential and none can compensate the other's absence. The process improvement team members can deal with only the first two, evaluating and analysing results being obligatorily performed by the top management.

Generalising improvement application implies:

- determining spots in which improvement can ensure benefits;
- determining the manner of improvement transfer;
- supplying necessary knowledge for improvement application.

By applying this modality for process identification and improvement in the two IT Romanian organisations throughout 2006 – 2008 (one organisation specialising in software products and an organisation specialising in producing and commercialising hardware) led to the following conclusions:

- continual improvement of the processes must be considered as
- integral part of the quality control system, not as a separate project;

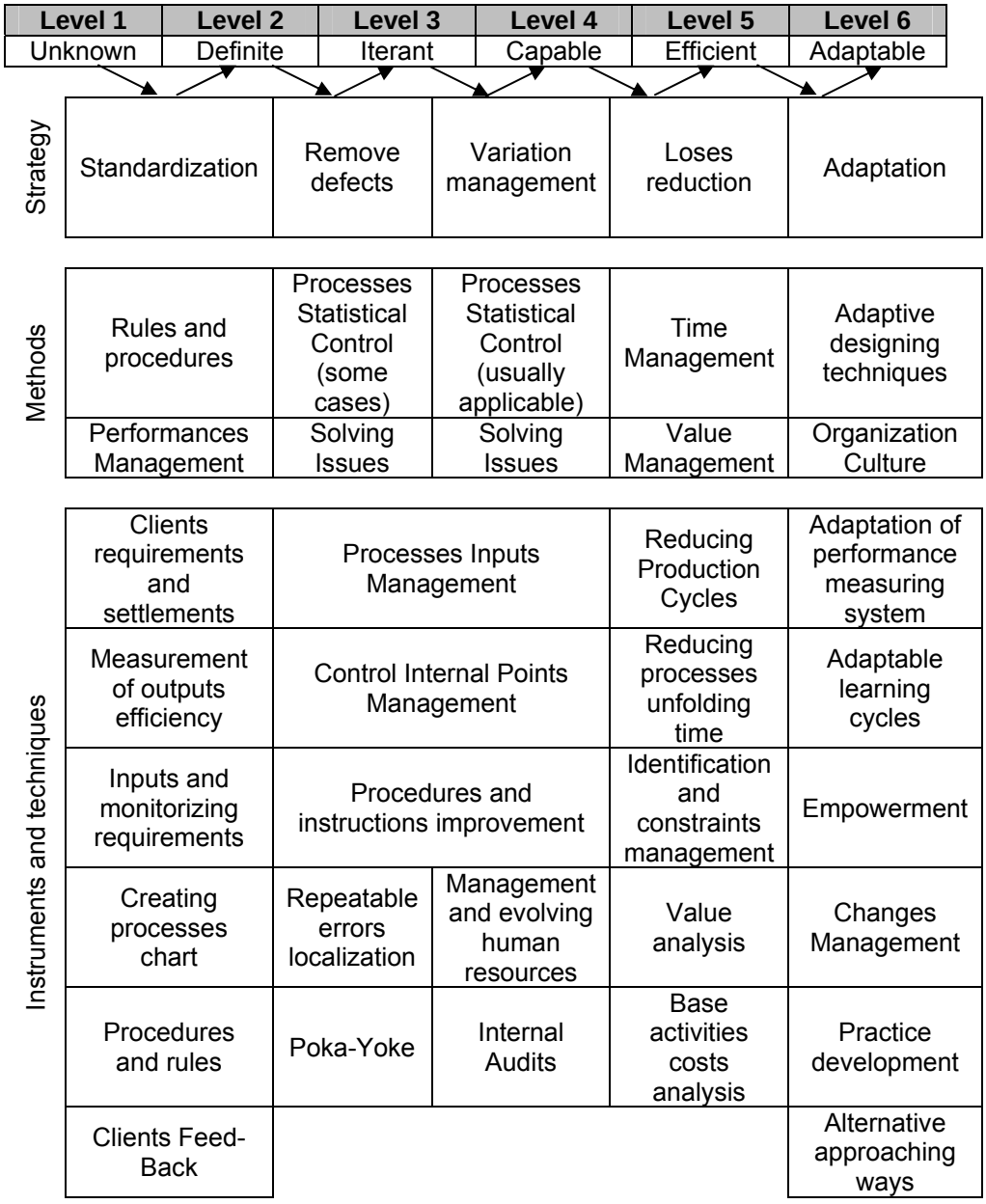

Figure 1. Proposals regarding IT processes improvement function of their maturity levels

- process improvement must be applied initially to processes relevant from a strategic point of view, otherwise it will be perceived by the personnel as being non-viable or unimportant;

- improvement must deal with processes in general, not only with their components. Focussing attention only on components, separately, can lead to negative results on the general processes;
- process capability must be systematically improved based on their maturity level;
- process improvement implies not only top management's support, but also their direct involvement.

Conclusions

Evaluating economic effects obtained by quality management system implementation

After implementing a quality management system according to ISO 9001:2000 standard a series of benefices are obtained relatively fast for most organisations. These initial benefices are generally due to improving organisation and communication within the organisations.

When an organisation adopts the ISO 9001:2000 standard, it must be preoccupied with their clients' satisfaction and the constant improvement of the products, personnel, quality control system and the business in general. Constant improvement is a process of growing the organisation's efficiency and efficacy in achieving its policies and objectives in the quality field.

In order to determine the costs involved by such an endeavour form the organisation's point of view, a distinction must be made between controllable and uncontrollable costs. In Table 1 both categories of controllable and uncontrollable costs are presented, which have been identified in the case of IT systems producers.

Table 1

Categories of controllable and uncontrollable costs identified in the case of Romanian IT organisations

No.	Controllable costs	No.	Uncontrollable costs
1	Costs generated by distribution errors	1	Costs caused by increase energy cost
2	Costs for inappropriate contract modifications	2	Costs caused by unpredictable events
3	Costs of errors in the products' specifications design	3	Costs generated by regulation requests
4	Costs of insufficient prototype testing	4	Costs caused by negative fluctuations of interest rates
5	Costs of multiplying and proper storage	5	Costs generated by significant changes of IT market
6	Costs generated by ambiguities in implementation manuals	6	Costs caused by certain demands of the client

Normally, an organisation can anticipate situations which can generate uncontrollable costs and can apply plans to counteract random events, and costs generated by them are accepted as a normal risk of the organisation. In certain cases, insurance for such risks can be purchased.

Most organisations pay attention only to controllable costs, their aim

being their identification and reduction. In order to determine these costs the following cost categories are to be taken into account:

- prevention costs – costs generated by evaluation activities, performed to prevent or reduce defects;
- evaluation (or identification) costs – costs generated by evaluating the degree of the product's conformity to the established requests (that is, identifying defects);
- internal defects costs – costs caused by defects identified before delivering the product to the client;
- external defects costs – costs caused by defects identified after delivering the product to the client.

Quality costs must be determined in each stage of the product's lifecycle, and at all the levels of the organisation.

Generally speaking, determining the four costs categories is fairly clear, but in situations when this is not possible, it is desirable to have a few criteria to allow an approach compatible with quality management principles, but without being in contradiction with accountancy principles (Parker, 1998), such as:

- o any form of planning represents a preventive activity;
- o any activity meant to ensure integrity to testing is a preventive activity;
- o preparing control mechanisms and defect treatment procedures, as well as effectively treating defects are part of preventive activities;
- o designing, implementing, maintaining and improving a quality management system is a preventive activity;
- o re-evaluating (re-inspecting, re-auditing, etc) consequently to correction measurements of initial problems is an activity of identifying defects;
- o low cost equipment or measurement instruments, considered as administration costs and used in evaluations, are evaluations costs during the year they have been purchased;
- o in the case of equipments used in production, development, assembly, both for evaluation and defect identification activities, costs must be assigned based on their usage duration for both activities;
- o cost control activities are preventive costs.

Both organisations pursue: decreasing total quality costs, reducing defect costs to quota significant lower than preventive and evaluation costs; reducing external defect costs to quotas considerably lower than the internal ones.

An ideal decreasing order of costs is as follows: prevention costs, evaluation costs, internal costs of defects, external costs of defects. This hierarchy represents a quantitative and concrete expression of a policy oriented towards satisfying the client. A pregnant manifestation of this orientation is thus a quantifiable process.

After studies performed the following distribution of quality costs before the implementation of quality management systems:

- prevention costs = 10%
internal defects costs = 35%
- evaluation costs = 30%
external defects costs = 25%.

This study concludes that there are quality costs due to defects which significantly exceed those which imply evaluating and adopting measures for detecting defects as early as possible, in the case when prevention activity is relatively negligible.

After implementing quality management system (and obtaining certification according to the ISO 9001:2000) the results have changed in the sense of significant increase of evaluation costs, but prevention costs have kept low (see figure 2).

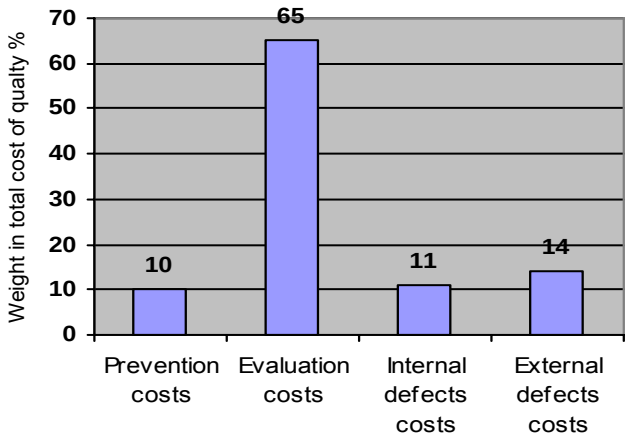

Figure 2. Quality costs structure after implementing the quality management system according to the ISO 9001:2000 standard

It is known that removing a product's defects and restoring its specific conditions is the more expensive the later defects are ascertained. When the defect causes unpleasant consequences to the client, the problem is not only limited to restoring the product to the specifications or replacing it, but may imply considerable damages, according to the legal responsibility for the product. Irrespective of the organisation's insurance against the eventuality of such damages, the cost of image credibility loss can be fatal to the organisation.

If hardware defects can be identified and corrected in the appropriate stages, then comparative factors for cost determination are as follows:

- design stage
- sub-ensemble assembly stage
- testing stage
- identifying the defect in usage

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Figure 3 presents cost correction variation of a software error function of its identification stage.

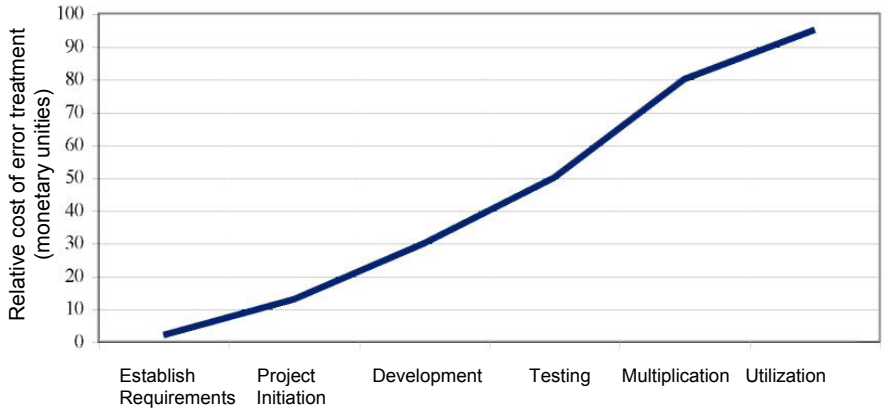

Figure 3. Correction cost of an error in the case of a software product

Intangible components, such as losing clients, decreasing sales due to clients' dissatisfaction, difficulties in entering other markets, can be evaluated only through market surveys.

In decisions referring to allotting resources in order to prevent supplying faulty products to the organisation's clients must take into account the following:

- through prevention activities: the number of defects is reduced, which allows both evaluation costs decrease and of all the other defect costs;
- through evaluation activities: defects are not reduced numerically, but they are only discovered and filtered by analysis, which leads to increasing evaluation costs and internal ones, but at the same time leads to reducing external defect costs.

Consequently, in the IT domain, investment in prevention activities are more efficient than in the evaluation ones, this fact being confirmed by practice, where prevention cost increase two or three times, or may lead to significant decreases of total quality costs.

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