# The Requirements Enhancement Based on a Problem Domain Model

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**Abstract.** The paper deals with the problem of the requirements enhancement related to a particular problem domain. New requirements related with problem domain (user, customer study program) are elicited and compared with the old requirements which are documented before. The modified Value Chain Model (VCM-based) framework for the refinement of new requirements, assessment and enhancement of old system requirements is developed and discussed. Enterprise management information interaction is specified as an Elementary Management Cycle (EMC), linking enterprise management function and process by a feedback loop. A modified Value Chain and Elementary Management Cycle model was created to describe management knowledge updating process. Proposed hierarchical modified Value Chain Model and Elementary Management Cycle model allows to structure domain knowledge identification and updating processes.

## 1 Introduction

There are many kinds of computing degree programs. There are dozens around the world. The variety of names used for the programs is even broader. The programs represent a number of computing disciplines. It is important that the computing disciplines attract quality students from a broad cross section of the population and prepare them to be capable and responsible professionals, scientists and engineers [1], [2], [3]. IS 2010 Curriculum Guidelines for Undergraduate Degree Programs in Information Systems is the latest report on the model curriculum work in the information systems (IS) field [4]. The Association for Computing Machinery (ACM), AIS (Association for Information Systems), AITP (formerly DPMA) and IFIP (International Federation for Information Processing) have contributed significantly to model curriculum development [5].
The requirements enhancement models are the set of activities used to define the life cycle model for requirements engineering. There are many requirements engineering process models [6] such as linear sequential model, linear iterative processes model, iterative process model and spiral model [7]. These models have certain advantages and

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disadvantages hence there is no ideal requirements engineering process model but the problems with requirements enhancement models can be minimized by making the active involvement of the stakeholders whose concerns need to be addressed [8]. Although there is no ideal requirements enhancement process but still it is possible to define a good requirements management process model [9].

**Related works.** The authors have proposed a semi-formal curriculum development procedure based on the use of requirements engineering methods and CASE tools [10], [11]. In previous works, the authors designed and implemented the engineering system of informatics study programs requirements based on the management of requirements documentation processing (requirements are kept in system database). In their work, the authors applied automated requirement engineering process for the establishment and modernization of a study program that is based on structural-functional approach: for requirement modeling the notation of Data Flow Diagram was selected. For the determination of the functions of study programs requirements management system, Integration of computer aided manufacturing DEFinition was used, etc. Traditional enterprise modeling methods (IDEF, DFD) used in informatics systems engineering, however, do not cover important social and technological aspects of organizational performance, such as organizational strategy and its relation to organizational structure, actors, organizational infrastructure Therefore, in this article a knowledge-based conceptual enterprise management modeling is used.

**Scientific Novelty.** The following results were derived: designed subject area (domain) management knowledge modelling procedure based on enterprise management information interactions; model of domain management knowledge content identification and knowledge updating computerized process, designed on the basis of a modified Value Chain and Elementary Management Cycle.

*Second section* introduces the application of a modified Value Chain and Elementary Management Cycle model for knowledge content description and updating is demonstrated.

## 2 The requirements enhancement based on the Value Chain Model

In organizational management practice Value Chain Model (herein referred to as VCM), created by Porter [12], is popular and has been used in works [13, 14]. This model represents current functioning activities (processes and functions) and their relations. VCM embodies a procedural approach to enterprise consisting of: primary activities (operational processes) and support activities (operational functions). Formal VCM description:

$$VCM = \{(F1,\ldots, Fi);(P1,\ldots,Pj)\} \quad (1)$$

here: (F1,… Fi) – enterprise management functions, (P1,… Pj) – enterprise processes.

The interrelationship between primary and secondary business processes explored in Gudas, Lopata [15] identified a different nature of these 2 enterprise activities: secondary processes possess informational nature and are referred to as enterprise (management) functions; while primary processes are concrete (non-informational) and are named enterprise (material) processes. In brief, the concept of Elementary Management Cycle (EMC) [16] is a formalised description of the Enterprise management control as the interaction between the Function and the Process – as two core components of enterprise from the control point of view [17]. The interaction between the core elements a Function and a Process is formally assumed as a Control Process [18] with the Feedback Loop between the Function F(i) and the Process P(j). Life cycle model of the study program content formation as modified Value Chain is presented in Figure 1.

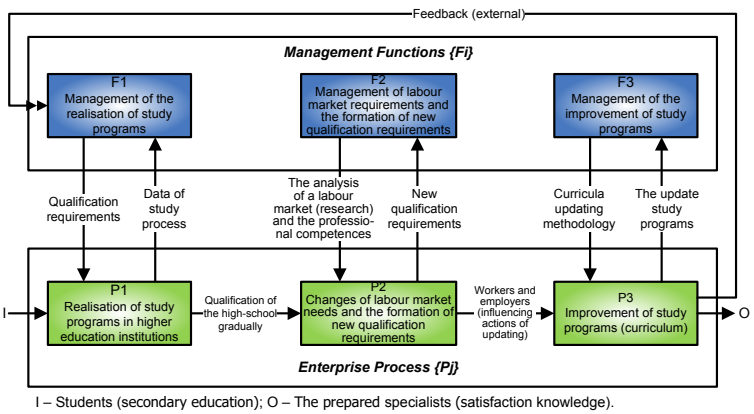


**Fig. 1.** Life cycle model of the study program content formation as modified Value Chain.

All of these requirements enhancement elements are closely interconnected and depend on each other in terms of the changes in education content.

The interaction between different layers is considered as the control loop (information feedback) as it was formally described by Gudas [19] as EMC (Elementary Management Cycle). The mandatory steps (Interpretation – IN, Data Processing – DP, Decision Making – DM, Realisation of Decision – RE) of the EMC are defined as information transferring processes focused on the control of the content of the management functions F. This paper presents more detailed content of the Function F(i) since it defines a sequence of definite types of interacting information activities directed to control the Process P(j). The structure of an EMC is provided in Table 1.

**Table 1.** The composition of an elementary management cycle (EMC).

| EMC component (element) | Description |
|---|---|
| Management function Fi. | Fi identifies a specific management function defined in EMC. Each element of a specific EMC (i) is defined in terms of this management function Fi. |
| Pj (A, G), Pj (V, G) – technological process (managed object). | Technological process, its input (I) and output (O) are material flows. Material flows are defined by state attributes of a specific process Pj, which are necessary to perform a specific enterprise management function Fi in combination with enterprise goals (G). |
| IN (A, B, G) – the interpretation of the state of the managed object. | Interpretation IN is performed according to enterprise rules that depend on enterprise goals (G). IN rules are a subset of organization‘s enterprise rules that forms systemized primary data B. |
| DP (B, C, G) – data processing. | Data processing (DP) is the solution of enterprise problems and data processing according to enterprise rules, which depend on enterprise goals (G). DP prepares data for the next EMC stage – process DM. |
| DM (C, D, G) – management decision making. | When making management decisions (DM), it is sought to fulfill enterprise goals and the requirements for controlling managed process Pj captured in them. Decision making DM is carried out according to the rules that depend on enterprise goals (G). DM output is a specific management decision intended to control the process Pj. |
| RE (D, V, G) – management decision realization. | Management decisions are carried out according to G requirements (rules). Management decisions realization output is the effects of management on process Pj, corresponding to the state attributes A of a particular process Pj and enterprise goals G. |

| | |
|---|---|
| G – enterprise goal (subgoal). | Each enterprise goal (subgoal) plans enterprise output requiring the implementation of a particular EMC in order to be achieved. Each subgoal is linked to the elements of a particular EMC. |

Transformation model (BPMN notation) is presented in Figure 2.

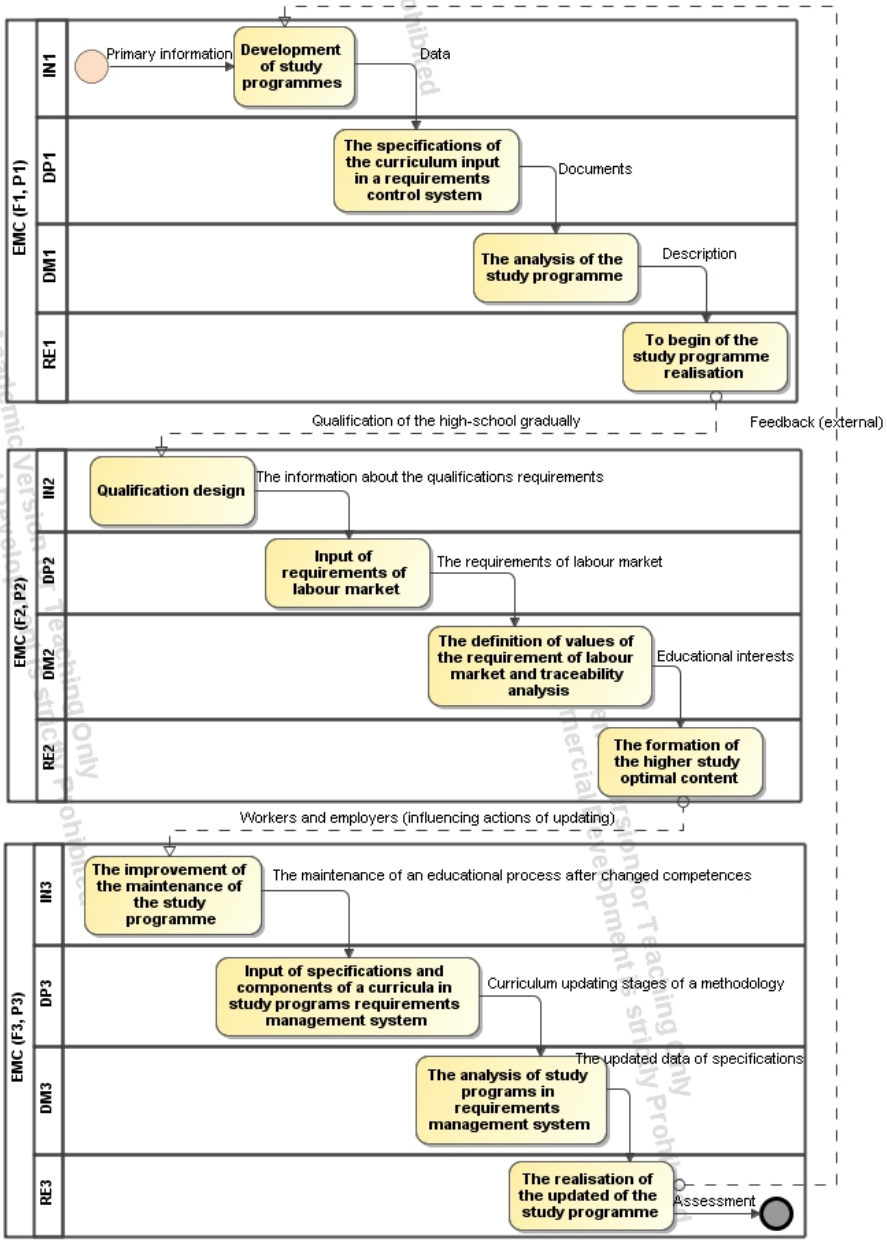


**Fig. 2.** Transformation model (BPMN notation).

For example, the formalised models of the interaction between the Function F1 = "Management of the realisation of study programs" and the Process P1 = "Realisation of study programs in higher education institutions", the Function F2 = "Management of labour market requirements and the formation of new qualification requirements" and the Process P2 = "Changes of labour market needs and the formation of new qualification

requirements", the Function F3 = "Management of the improvement of study programs" and the Process P3 = "Improvement of study programs (curricula)" are presented in this paper [20].

The principal scheme of the old requirements which are documented before is illustrated in Figure 3, the new requirements related with problem domain is presented in Figure 4.

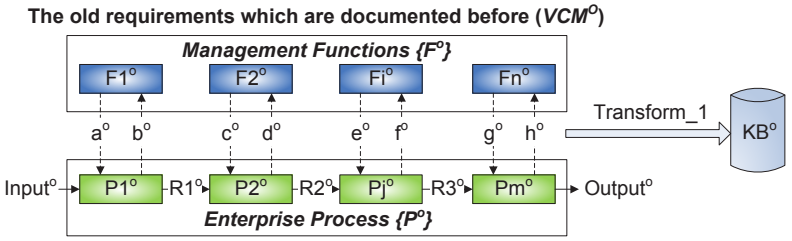


**Fig. 3.** The old requirements which are documented.

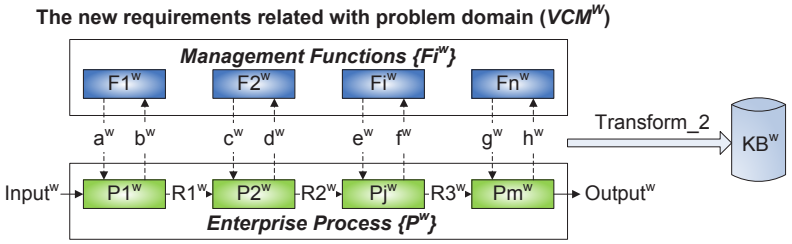


**Fig. 4.** The new requirements related with problem domain.

The identification of differences of the old requirements which are documented before and the new requirements related with problem domain is presented in Figure 5.

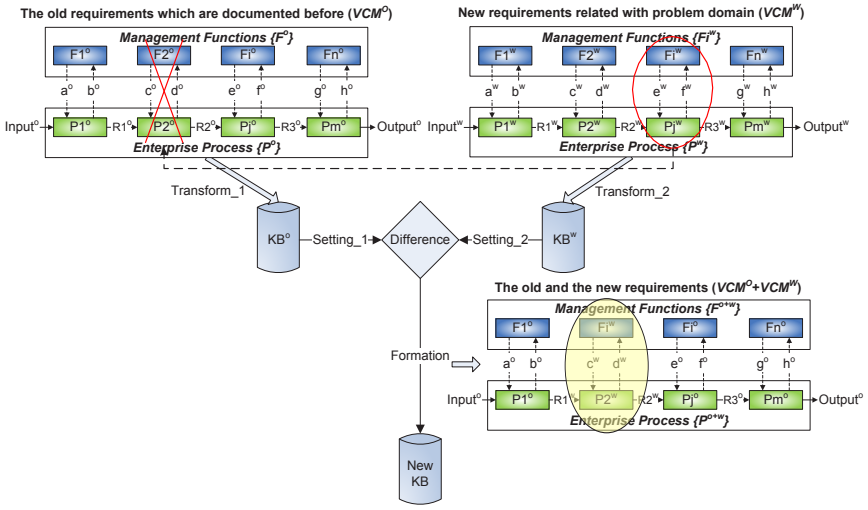


**Fig. 5.** The identification of differences of the old and the new requirements.

Within the CASE measure special visual environments or views for requirement analysis are selected. It is possible to review requirements in several views by using various matrixes where requirements and their attributes or traceability links between different requirement types are represented.

A method of requirement analysis is Traceability Matrix that shows the relation of two requirement types. Traceability Matrix (Fig. 6) shows how different components are linked

to study outcomes (an arrow pointing from one requirement to another shows direct traceability).

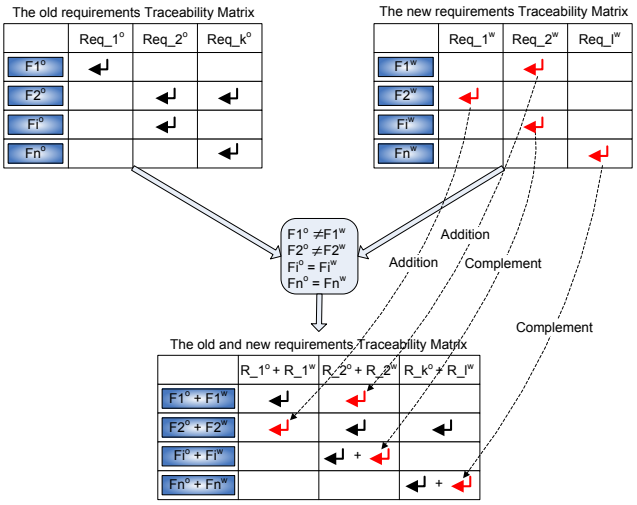


**Fig. 6.** The relations between the old and the new requirements.

Requirement Traceability Matrix is used when applying decomposition principle called ”top-down approach“ by consistently dividing a selected component into subcomponents as many times as it makes sense in terms of a modeling goal.
One of the key techniques in Entity-Relationship modeling is to document the entity and relationship types in a graphical form called, Entity-Relationship (ER) diagram. The Entity-Relationship diagram of knowledge repository is presented in Figure 7 (illustrate the logical structure of databases).

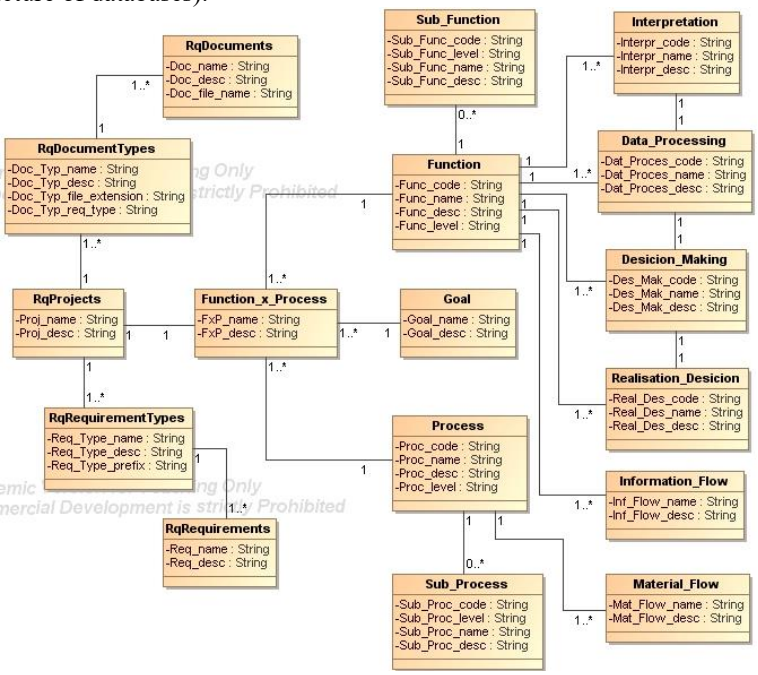


**Fig. 7.** The Entity-Relationship diagram (a logical level) of knowledge repository.

The Entity-Relationship diagram of knowledge repository specifies elements which can be a function, a process, a material flow, etc.

## 3 Conclusions

The presented framework of the knowledge-based Enterprise Management System architecture is aimed to develop practical methods for the knowledge-based enterprise modelling and implementation.
The formalized analysis and modelling of the Function–Process interaction refines a set of new constructs of the Enterprise modelling. The presented approach uses the modified Value Chain Model for the description of the enhancement procedure of the problem domain knowledge.
A domain management knowledge modelling procedure was designed, allowing to create a two-level (granular) model for describing knowledge of domain management information interactions: the highest level modified Value Chain Model is further elaborated into a set of Elementary Management Cycle models; the chosen hierarchical structure allows to create new structural knowledge models and to update existing ones.
As a result, the requirements enhancement processes has been constructed and discussed in this paper.

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