Standardized Individual Output Development: Linguistic Approaches for Requirements Engineering Problems Through Cultural Differences - Case Studies from Requirements Engineering Education in the Context of E-Publishing at the Chair of Book Studies

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Abstract

In this paper, the approach of Standardized Individual Output Development is investigated in relation to the use of linguistic standards to resolve cultural differences in the requirements engineering. For that culture and requirements as problem-space and the theory of Standardized Individual Development as solution-space are described as a basis for the subsequent empirical investigation by a case study.

Keywords: Standardized Individual Output Development, Linguistic, Culture, Requirements Engineering, Transfer, Creativity
Introduction

“The limits of our language are the limits of our (cultural) world.” (Wittgenstein 1922). Wittgenstein’s statement combines the challenge of communication through natural language: Natural language consists of the technical aspect (grammar) and the meaning as a bundle of semantics, pragmatics and culture (Watzlawick et al. 1974; Rupp et al. 2009; Wittgenstein 1922). The cultural aspect can lead to defects in the requirements analysis of systems - Cause for subsequent design flaws and ultimately for economic or harm to people, in the case of construction errors in the automotive or aircraft development. The challenges of cultural differences are to analyze and derive solutions. Transmissions of linguistic approaches are a way to solve the problem (Rupp et al. 2009). The contribution enters the debate at this point.

Challenges are worked out regarding the cultural perspective and the value of natural language for requirements engineering and examples of analysis techniques in linguistics are presented. Based on the implicit description of an instance of the reuse of concepts from linguistics, their use in psychotherapy for Neuro Linguistic Programming (NLP) (Bandler et al. 1982), the theory of Standardized Individual Development is presented (Fahsel et al. 2014). As a result, it is shown how the problem of abstraction leads to new solutions through the transfer of abstracted existing solutions. As an outlook, a holistic approach is outlined, a lingua franca of modeling approaches from the Linguistics connects to a unified concept language that cultural boundaries of language overcomes, and as an example of the economic sustainability of the humanities, in the specific case of linguistics. Methodically, the research objective will be implemented as follows: First, the problem of cultural differences in requirements engineering will be investigate literature based. Then the own approach to Standardized Individual Output Development is presented as a theoretical basis for a systematic solution finding. Problem and solution approach form the basis for subsequent empirical survey on the research approach of the case study. Conclusion of the essay forms the summary of the results and an outlook.

Cultural Aspects

The engineering process is a multi-step transformation of ideas into artifacts (Herrmann et al. 2014), in which RE is the first step for transforming ideas of future users or their representatives (managers etc.) in a representation. Each actor in this process is influenced by his/her own cultural context. Studies on intercultural aspects in international cooperation emphasize the influence of different national or ethnic cultures that has an impact on the handling of requirements, for example in the aspect of the non-critical acceptance of the requirement documents, even if they contain unrealistic requirements (e.g. Overhage et al. 2010, von Stettn et al. 2012).

But the term “culture” is not restricted to national or ethnic aspects. Hofstede defines culture as “the collective programming of the mind
distinguishing the members of one group or category of people from another” (Hofstede 2014). Therefore, we have to consider aspects of organizational culture and of professional culture besides international aspects. All these types of cultural aspects can be described by the six Hofstede (Hofstede 1980) factors of culture: Power distance, Individualism vs. collectivism, Uncertainty avoidance index, Masculinity, Long-term orientation vs. short term orientation, Indulgence versus restraint (Hofstede 1980).

The obviously most discussed aspects of interculturality are international aspects. Hofstede defines that “The category can refer to nations, regions within or across nations, ethnicities, religions, occupations, organizations, or the genders.” (Hofstede 2014). This dimension of interculturality is widely accepted and discussed in science and in practical work and trainings. “Globalization” of business is an awareness driver for international aspects. The usage of different languages in different nations influences directly the RE process.

A second influencing factor is the organizational culture. This is – according to (Schein 1984) – “the pattern of basic assumptions that a given group has invented, discovered, or developed in learning to cope with its problems of external adaption and internal integration”. Hofstede observed: “[...] organizational cultures – that is, the differences in collective mental programming found among people from different organizations, or parts thereof, within the same national context. [...] Whereas national cultures differed primarily in their values, organizational cultures turned out to differ mainly in their practices.” (Hofstede 2001, p. 373). The six dimensions of organizational culture according to Hofstede (Hofstede 2001, pp. 397-399) are:

- “process-oriented versus results-oriented,
- employee-oriented versus job oriented,
- parochial versus professional,
- open versus closed (communication climate),
- loose versus tight amount of internal structuring, and
- normative versus pragmatic”.

The organizational culture focuses on the internal relationships within an organization. The learning experiences of a company, its strategy and its tradition are important aspects. Hofstede (The Hofstede Center 2014) lists the following dimensions of organizational culture: means-oriented vs. goal-oriented, internally driven vs. externally driven, Easygoing work discipline vs. Strict work discipline, Local vs. Professional, Open system vs. Closed system, Employee-oriented vs. Work-oriented, Degree of acceptance of leadership style, Degree of identification with your organization.

The third influencing factor of interculturality is the professional culture. There is not as much literature on professional cultures as on national or organizational cultures. Herkenhoff measures differences between professional cultures using the Hofstede dimensions (Herkenhoff 2010). She points out the relationship between the professional cultures and the national cultures: “Just as Hofstede notes that national culture is not genetically shared but is passed
down between groups, the same holds true for professional culture.” (Herkenhoff 2010). One aspect for example is the long-term vs. short-term orientation of professions (Bond 1988). In this dimension, computer programmers and other people engaged in project work may be short-term focused.

Herkenhoff (Herkenhoff 2010) developed a Professional Culture questionnaire (PC08) based on Hofstede/Bond as a tool for measuring along the dimensions of Power, Time, Risk, Service and Team. In her study, she compares professional culture rankings of people working in accounting, IT support, sales and science. Referring to the five dimensions of professional culture (Power, Time, Risk, Service, Team) IT staff shows high ranking values for team orientation and service, but only low values for long term orientation.

In some disciplines, stereotyped archetypes of persons and their character behavior exist. For professions in the healthcare business, Hall (Hall 2005) describes such differences and shows that the interaction with other professions is limited with increasing specialization of learners (Hall 2005, Hall and Weaver 2001).

According to Hall 2005, an individual has its own cognitive map, which “develops as a consequence of the educational and socialization experiences of the students of each profession, built on each student’s own unique cognitive and constitutional make-up. This map is a major component of the culture of each profession.” In this description all three aspects of culture are influencing the mind of the individual. In IT business a study on communication problems in distributed software development (Stein and Herrmann 2013) shows cultural differences not only between countries, but also between different organizational cultures, younger and older people and different professional cultures (like software developers versus managers or customers).

With a slightly different meaning, some authors in the related Business Process Management domain (see the literature review of von Brocke and Sinnl 2011) discuss about “subgroup levels” (Leidner and Keyworth 2006) or “work group cultures” (Baba and Falkenburg 1996 and others). It is important to consider that all these cultural factors – international, organizational, professional – together with the influence of other individuals and groups will influence the individual position and the individual behavior of the actors in the RE process.

Figure 1 shows the influences from the three cultural aspects on the actors in the requirements process. The difference in the cultural settings complicates the communication process. Furthermore, the language itself is influenced by nation, profession and organization, with descending impact.
Figure 1. Three Different Cultural Influences in the RE Process

The differences in the cultural aspects may vary between the different settings. While Figure 1 shows a possible situation in an international setting with a consulting company (doing the requirements engineering) and a customer’s company, Figure 2 describes a typical “inhouse” situation in a SME with only internal staff from one nation.

Figure 2. A Different Setting of Cultural Influences in the RE Process

Standardized Individual Output Development

The concept of the Standardized Individual Output Development can generally be understood as an approach to the development of output using its own standards, or re-use of standards from other domains via analogies. Objective is a systematic and qualitative creation of individual output on the one hand. On the other hand the innovation support on knowledge transfer in the first and future step by mechanical creativity. Subsequently, the core ideas and principles are introduced.

Starting from a requirement there is a concrete output creation using the concept of Standardizing Individual Output Development. The result of this process is the Standardized Individual Output. Figure 3 visualizes the overall process.
Fundamentals of the approach are the work of Göpfert (2009), the concept of individual output and the mass customization (Piller 2001). Göpfert describes the individual output as a transition from craft to mass production through standardization and automation to individual output via standardized process modules which are not visible for the customers (Fahsel et al. 2014; Lasi et al. 2014). Similarly argued Piller (2001) with the strategic approach of mass customization as a strategy variant between standardization on one hand and differentiation called mass production on the other.

Based on these basic considerations the Standardized Individual Output Development describes a design process in terms of a reference model for the development of customized outputs through a systematic re-use their own standards or other domains through analogies. A conceptualization of the core idea is carried out via the framework of the Standardized Individual Development Cube (SIC), which is interpreted both as a synthesis of different approaches and in the subsequent step as an analytical tool.

The SIC as a synthesis embraces the connection of standards within a domain and the value chain in an output process – called the Standard Catalog. Regarding to the output development on the re-use of standards from other domains, the SIC includes the dimensions domain and standards – called the Standard Innovation (Figure 4).
A brief introduction is following of the *Standard Catalog* and *Standard Innovation* as an interpretation of slices of a cube that is based on the OLAP (Online Analytical Processing)-Cubes operation of slicing (inspired by discussion by van der Aalst 2013 to Process Cubes). The *Standard Catalog* as vertical slice is here interpreted as a function of standard and value chain and based on the work of Schacht (2009) and Fettke and Loos (2002).

Schacht discussed the one hand, the interpretation of standards as explicit knowledge; he furthermore classifies standard categories and allocates the value chain to individual standards. Building on this idea standard categories have been defined on the one hand in the *SIC* as a synthesis of the work of Schacht and Hertel (2009) and as a transfer of product-, output view and integrated communication techniques of the ARIS-Framework (Scheer 1999). The genesis of the approaches leads to the following characteristic values of the standard dimension: *product/quality standards*, *process standards* and *communication standards*.

The idea of domain-specific storage of standard knowledge based on the work of Fettke and Loos (2002) who formulated a catalog of specific process standards called reference model. In summary, the vertical slice in *SIC* is called *Standard catalog* and describes the idea to understand standards as knowledge to assign this standards to the value chain (Schacht 2009) and to provide (intelligent) searchable knowledge Databases in a subsequent step (Fettke and Loos 2002). Here the question arises, according to the development of output demands, for which no standard reusable knowledge exists. This requirement is solved through the *Standard Innovation* slice.

The *Standard Innovation* based on the work to the TRIZ approach (Mann 2001) and the analogies on the pyramiding approach (Poetz and Prügl 2014). If a problem cannot be solved through existing standard knowledge from the *Standard Catalog*, it is necessary to transfer the problem to another industry: If
solutions for the abstract same problem exist, it can be reused. The methodology of the problem of abstraction in step one, the search for solutions at an abstract level in step two and the final solution to transfer their own specific level is part of the TRIZ approach. While abstract problem-solution mappings are done by pattern search in patents in the TRIZ approach, in the pyramid approach of Poetz and Prügl (2014) interviewing of experts in analog domain are used to achieve this goal.

To summarize, the slice of the Standard Innovation forms a synthesis of the TRIZ and the Pyramid Approach. The basis is the finding of abstract problem for a concrete problem, then the search for solutions at an abstract level by domain analogies and in the last step the transfer of the abstract solution to the specific domain level. The practical implementation can be reached in following iterations:

1. The transfer of knowledge through expert knowledge and human communication.
2. IT-supported standard knowledge storing of various domains and human interpretation.
3. IT-based knowledge storage and sophisticated machine connecting of problem issues of different domains (e.g. Schacht 2014).

Standard catalog and Standard Innovation form the basis of the approach of the Standardized Individual Output Development, be modeled as a synthesis of different theoretical and practical approaches in the SIC and form the basis for the transformation of the synthesis cubes into a concrete IT-supported analysis cube for automated Standardized Individual Output Development (Fahsel and Schleifer 2015). Specific design of Standardized Individual Output Development in the case of requirements engineering at the Institute for Book Studies is the subject of the following Case Study.

Case Study

The design of the Standardized Individual Output Development using Linguistic knowledge standards is subject of the following described case study investigation.

Case Study Investigation

A case study analysis is concretized in definition of research subject and research questions, implementation design and subsequent execution.

Research subject of the contribution is the Standardized Individual Output Development in general and in particular the consideration of cultural problems in requirements analysis and their solution on linguistic approaches. Research objectives of contributing were on the one hand in the processing problems in requirements engineering and the conceptual preparation of the Standardized Individual Output Development, and on the other hand the empirical
investigation. The empirical investigation of this proposed approach is based on the research method of case study with the following design (Yin 2013):

- **Objective:** The research subject of the *Standardized Individual Output Development* in the Publishing Industry is a relatively unexplored area of research, so there is a theory-building output in focus. With regard to the research purpose a phenomenal research interest will be at the focus.
- **Object Selection:** With regard to the target position, the individual output development under consideration of linguistic approaches to solving cultural problems in requirements analysis, two projects at the institute for book studies are considered in terms of a holistic multi-case study.
- **Data Collection:** Why and how questions are a key part of the study. For that reason the collected data are more qualitative than quantitative. In addition by participant observation the study includes interviews and content analysis to ensure the quality of the collected data.
- **Evaluation:** The case studies will first individually and the following step analyzed across. The individual evaluation is preceded by a short project presentation, and then the particular standard used is analyzed.

The standards used with regard to the theory of individual output on the one hand and the linguistic contribution to the solution of cultural differences on the other hand were considered in the last step.

**Case – “Template Approach”**

The project group had the task to convert the annual report of Erlangen Institute for Book Studies into an online version so that a reader individual configuration of individual semantic units can be accessed. As a result, the individual requirement of the individual reader configuration via an extension of the WordPress CMS was achieved through selected plugins. The individual output, the reader individual configurations of individual semantic units, was achieved through a solution-neutral documentation of requirements on the *Template Approach* as a basis for subsequent derived analysis of solution variants and final technical implementation (Fahsel and Schleifer 2015). In the approach of *Individual Standardized Development* the used *Template Approach* is carried out both as input (standard) and output (individual output).

First, the *Template Approach* is investigated as a standard (input). Here the following question is in the focus of analysis: What specific problem occurred in the output development within the project and how was the *Template Approach* standard used for the output development?

The concrete challenge was the correct and full documentation of customer requirements. A problem field for which no standards in the book science exist and thus the students were unable to access a domain-specific knowledge catalog. Alternatively, the possibility remains of the SIC- technique of *Standard Innovation* across domains analogies. There is the possibility of an
expert survey regarding standards of analog domain or the problem solution by an IT System. In the project the expert survey was used. Following the TRIZ approach the specific problem of the project was abstracted whereby it became associated with the domain of Software Industry and here the requirements engineering (Mann 2001). In the context of software and system development, the challenge of collecting customer requirements on a semiformal language is solved by the Template Approach, which leads to structured requirements, as formalized input for the following steps of design and implementation (Rupp et al. 2009). After finding the standard knowledge in the form of templates that approach was used in the project and ensure on the one hand the completeness of the requirements on the use of rules and on the other hand, the structured requirements definition via templates. A significant contribution to the project’s success – only what is correct formulated leads to a system that is doing the right things (Requirement Responsibility) and doing the things right (Construction Responsibility). Figure 5 illustrates the elements of a template and shows a concrete template instance of the project.

Figure 5. Structure and Application of Template Approach

With regard to the consideration of the Template Approach as an individual output the already mentioned regulations for complete requirements analysis will be explained. The semiformal natural language requirement description Template Approach consists of two components: a syntactic part – the already presented templates and a semantic part – the rules and the Glossary. Here the template is the concrete result. The transition as the way from customers (unspeakable) needs to persisted requirements documentation with templates are done among others by standardized rules (Rupp et al. 2009) which systematically eliminate losses through representation transformation through language. Cause of transformation losses forms in simple terms the difference between “what is thought” (deep structure) and “what is said” (surface structure) (Chomsky 1968). Figure 6 visualizes the problem.
This distinction between deep structure and surface structure is caused among others by cultural differences and can be systematized in *Deletion*, *Generalization* and *Distortion* (Rupp et al. 2009; Chomsky 1968). This raises the question as to remedy this faulty retranslation of *Derivation* (Chomsky 1968) and in the specific case the understanding of the original “internal” but not completely outspoken customer need. Initially, there was no solution in the domain of the IT Industry. Via a standard innovation of approaches of Chomsky (1968) for the differentiation of deep and surface structure, the application of the standard knowledge of transformational grammar of Chomsky in Neurolinguistic Programming (NLP) of Bandler and Grinder (1982), a standard composition was bundled in an individual output for semiformal requirement method, the *template approach*.

In summary, the individual requirement of the project has been transferred to individual output, among others through a *Standard Innovation* of the *template approach* from Software to Publishing Industry. The *template approach* itself is to be interpreted as an individual output from different knowledge standards in the linguistic environment, as shown in the Figure 7.
Figure 7. Individual Project Output as a Component of Individual Output Composites

Case – “Holistic Approach”

Currently a variety of communication methods, natural and artificial languages for the concept definition are used in a large German authority. Challenges consist in: (1) the effort of creating different concepts, (2) risks associated with the transformation of information into different concepts and (3) the traceability between the concepts due to various languages.

Therefore, an objective is to develop a holistic language for creating business concepts. The holistic approach should provide a common language for all participants. The basics of the holistic concept were first presented in 2013 at the chair for Software Engineering by Jörn Fahsel and Raphael Dudek (2013). In this context the project addresses the question to which solutions for holistic concept descriptions exist, and then based on this to evaluate the approach of Fahsel and Dudek (2013) and finally uses the won cognitions to expand the approach.

The holistic approach tries to solve the challenges of demand for natural language formulation by the departments and a semiformal communication in the technical context. Hereby the problem exists by transformation of concepts,
which on the one hand causes an increased expenditure of time the other hand, transformations inherent leads to loss of information (discussed in Fahsel 2003). This raises the question of solving the problem; in the terminus of the SIC an output requirement for a holistic approach.

As no Standards in the Publishing Industry exits a standard knowledge of other domains must be used. A contribution to the output development of a holistic approach provides the *template approach*. By its natural language character this is more reflecting the culture of departments and less of technical experts which prefer semiformal or formal description. In the technical environment Unified Modelling Language (UML) is used as a communication standard. One possible approach provides the link between template set as the language of the department with understandable and simplified diagram characteristics of UML.

Following Wittgenstein statement – “the limits of my (cultural) languages are the limits of my world” is to ask to what extent the idea of a holistic concept has been fully penetrated. The designer is limited to its (language) design (Wittgenstein 1922). How is this dilemma solved? Transferred to the SIC, the question arises for a standard for this requirement. The maieutic is a process standard of ancient Greek civilization that was used here. “I know that I know nothing” as a basic attitude, to help the respondents in the genesis and open up the questioner at best to new knowledge and help him to put his constructions in question (Lütjen 2013). Based on the fundamentals of maieutic a depth interview with project participants was carried out and as a result the “world” of the holistic concept has been expanded as shown in Figure 8.

**Figure 8. Identified Features of a Holistic Concept**

In summary, the approach of *Standardized Individual Output* was investigated in relation to the use of linguistic standards to resolve cultural differences in the requirements analysis in the case studies. On the one hand, the approach of the *Standardized Individual Output Development* has proven to be more stable framework for description of phenomena; on the other hand the
innovation output by use of linguistics approaches were identified. The result of the cross case synthesis is described in Figure 9.

**Figure 9. SIC as an Instance of the Composite Pattern**

Finally the *Standardized Individual Output Development* can be interpreted itself as an individual output of the composite pattern whose transition to a standard depends in using of the approach in different contexts.
Learning and Outlook

The case study shows the application of the Standardized Individual Output Development to solve the problem of cultural differences in requirements engineering. Cultural differences within national, organizational or professional cultural aspects can thus lead to incorrect requirement descriptions and form in interpretation of the Standardized Individual Output Development the output requirement. The Template approach and holistic approach form individual output to solve the culturally conditioned communication deficits.

Both, the template approach and the holistic concept approach, are interpreted as compositions whose development based on the use of linguistic standard blocks among others NLP, transformational grammar or Maieutic. In summary the empirical investigation supports the approach of Standardized Individual Output Development on Standard Catalogs and Standard Innovation in general, and the sustainability of linguistics as a standard building block supplier to the Standardized Individual Output Development in particular. The outlook on current research projects of the cultural challenges in requirements engineering theory on the one hand and the use of SIC for an institution independent education on the other hand forms the conclusion of the contribution.

As shown in the article, (Inter)Cultural aspects play an important role in requirements engineering, on the one hand in practical application but also in teaching. Investigations in this context are rather underrepresented in the research. Derived from that requirement a first draft for a collaborative research project was created (Herrmann et al. 2014) and will be expanded to an international research project in the next step about gaining of international project partners. As a technical platform for the collaborative creation of scientific papers in the project the online based authoring system of the cooperation partner Appsoft from Munich can be used for free. The authoring system Xeditor is shown in Figure 10.
Sustainable Education as the foundation for a sustainable development of a people, the economy and the environment forms the second outlook. In the interpretation of education as a fundamental right (Nussbaum 2011; Rawls 1971), the challenge is a global, high-quality, local and individual customized education (Aubert et al. 2015). In particular, for Third World countries a problem: Here is a great demand for education, but the supply of well-trained teachers is difficult (UNESCO 2014). According to a study by UNESCO (Aubert et al. 2015) two million new teachers would be needed only to ensure primary education. Solution offers Innovations of Information Communication and Technology (ICT). New and enriching possibilities to improve education and ICT in particular have been discussed by mobile devices, networking, and digital services. Experiences in South Africa with separation of education and organization through mobile devices and digital services demonstrate the potential for a more equitable distribution of education worldwide (Aubert et al. 2015). This is where a current contribution relates to: The stress field of qualitative, global and sustainable education should be solved by an institution-independent education via digital and networked media, e.g. Big Data Learning and Adaptive Books (Razek and Mohdyan 2013; Swertz et al. 2013) or Book slicing (Baumgartner et al. 2004). Theoretical brace around this outlook constitutes the theoretical approach of Standardized Individual Development (Fahsel and Schleifer 2015). On the one hand to model the relationship between capabilities and then bundling and also new bundling them to functions (Paul and Lopez 2001). On the other hand, as a framework for systematizing reuse standards to create new learning opportunities. In the specific case of digital written media based individual services in support of sustainable education.
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