Evaluation and Classification of the Semantic Congruence of Information in Concurrent Product Development

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ABSTRACT

The paper at hand describes some instruments necessary for evaluating the semantic congruence of information qualitatively as well as quantitatively and for an assignment of characteristic profiles of semantic congruence to specific combinations of decisions and tasks in concurrent product development. The assignment is of high relevance for evaluating the sufficiency of the semantic congruence of information available as a basis for decisions to be done within concurrent product development.

Keywords: Information management, semantic congruence of information, criteria for evaluation, measured values, processing the evaluation, kind of decisions and tasks, information profile, concurrent product development

1. INITIAL SITUATION

To cope with the hard international competition, nowadays, product development is done in concurrent structures of different companies or organizations representing a complex business system. Concurrent product development needs an intensive exchange of information between the single development partners of the business system. This information often is characterized by an incomplete semantic congruence. The author defines the semantic congruence of information *"as the analogy of the information contents and characteristics made available by an interaction with the information contents and characteristics necessary for making a decision in a product development process"* [A]. To minimize trial and error processes during a product development process caused by an incomplete semantic congruence of this information, there is the need for an instrument which allows evaluating the semantic congruence qualitatively as well as quantitatively. By using such an *evaluation instrument*, the organizations or actors using the information exchanged via an interaction will be able to decide if the semantic congruence of this information will be sufficient for the decisions they will make within a product development process or if short-term actions for making these information usable have to be initiated. In addition to the ability to evaluate the semantic congruence of available information qualitatively as well as quantitatively there also is a need for an instrument which classifies this information as complete or incomplete in specific product development situations. Depending on specific kinds of decisions and tasks the user of the information must gain the knowledge if the semantic congruence of the exchanged information will be sufficient for a decision due to be dealt with, which means if the information content is suitable and if the information characteristics meet the requirements for coming to an expedient decision. In case of inadequate suitability of the information content as well as of its characteristics, short-term actions for improving the information quality have to be initiated.

For reproducing a realistic illustration of the semantic congruence of information some core requirements to the *evaluation instrument* have to be fulfilled: Firstly, the instrument must reproduce the parameters for describing operative information and communication structures specified below, because these parameters indicate an incomplete semantic congruence of information. Secondly, the instrument must give hints which of these parameters have to be influenced to create a higher level of semantic congruence of the information exchanged. A third aspect to improve the usability of the described instrument as well as to condense the evaluation results in one value is the introduction of a quantitative representation of the semantic congruence of information by the instrument.

An important precondition for an evaluation of the quality of information available is a clearly fixed borderline between complete and incomplete information. To find this borderline a sufficient semantic congruence of information is defined. This definition is worked out regarding to specific kinds of decisions and product development tasks. For finding the definition, as a first dimension the relevant kinds of decisions in concurrent product development are identified. A second dimension is given by the kinds of tasks to be fulfilled for developing complex products. These relevant kinds of tasks have been worked out by analyzing concurrent product development processes. By linking the two dimensions to a system of decision-/task-combinations and by assigning a metric for evaluating the semantic congruence of information [A] to the developed system an instrument is created which allows a classification of one out of three characteristic minimum profiles to these defined decision-/task-combinations. This assignment finally leads to the aimed differentiation between complete and incomplete information in concurrent product development.

2. EXISTING THEORIES AND WORK

In Europe there are only a few works investigating the semantic congruence of information in detail. Most of the authors, e.g. *Krcmar* or *Picot* et al. [2, 3], focus on theories and models for information management in which they only describe the phenomenon of a lack of semantic congruence of information exchanged against the information needs. But they hardly give any solutions to cope with this lack of information. Only *Derichs* in his doctoral thesis [4] worked out an approach to utilize insecure information [5] in simultaneous engineering systematically for reducing product development time.

The developed evaluation instrument of the semantic congruence of information bases on research in the field of information logistics: In this field some core parameters were identified which are crucial for describing information and communication structures. *Thoben*, *Weber* and *Oehlmann* developed a methodology to analyze and improve such structures on an operational level [6, 7, 8]. They defined this level on which the structures are described very detailed as interaction and called the appropriate methodology *Formal Interaction Analysis*. Out of this methodology the parameters for describing operative information and communication structures – so called interactions – are identified as information contents, information characteristics, information needs, information sources, information objects, communication patterns and finally information users. The identified criteria for evaluating the semantic congruence of information are directly linked to these core parameters.

Two further scientific directions which serve as a crucial base for the developed instrument are the process management theory as well as the organization theory. Many of the methods and tools for the evaluation of semantic congruence of information are taken from the state of the art of theses fields of science. E.g., the number of five classification levels for the metrics presenting a qualitative evaluation of the semantic congruence of information can be found at the Capability Maturity Model [9] or at the *Likert Scale* measuring the strength of persons' agreement towards a set of five clear statements [10]. Also, the steps of processing the evaluation of semantic congruence of information are following the classic approach of examining an issue which is analysis – conception – application.

The basis for identifying decisions relevant in concurrent product development is the *decision theory*. European scientific literature of the decision theory describes defined environmental conditions which are linked to mathematic models of probability to determine the optimal results of a decision regarding to specific aims [11, 12]. The possible environmental conditions can be named as certainty, uncertainty and risk. The classification of the identified kinds of decisions is related to these environmental conditions to get a rough idea how to handle these kinds of decisions. Further more, within the decision theory a *generic decision process model* dividing a decision process into four phases is described. According to this model a further decision processes model for concurrent product development was developed [13]. The most important of this model's phases which needs transparency of the level of completeness of the information available is the phase of finding a solution.

To create a suitable base for formulation the characteristic minimum profiles of the semantic congruence of information as a second dimension the kinds of tasks relevant in concurrent product development are identified. The identification of these kinds of tasks is based on a *model describing a development process of complex products in a generic way* [14]. The author created this model out of two process models representing the product development processes of a ship on the one hand and an assembly line for automobile combustion engines on the other hand. This generic model summarizes the product development tasks on an abstract level. From the analysis of these product development tasks the author identifies six original development tasks to be fulfilled within concurrent product development systems, which are analysis, conception, structuring, calculation, detailed design and elaboration. Further more, three typical tasks supporting the concurrent product development are identified on basis of the state of the art of organizing the proceeding of product development as a project [15]. These tasks are identified as planning, managing and controlling.

Summing up, the two dimensions described above are combined to a system of decision-/task-combinations. The development of this system bases on approaches and models taken from theory as well as from practical experience. Thus, this system is in charge of a reliable theoretical as well as practical basis.

3. RESEARCH APPROACH

Both of the instruments, the evaluation instrument as well as the instrument for classifying the available information as complete or incomplete, are developed via a structured course of approaches and thoughts.

Thus, the first step of the development of the instrument for evaluating the semantic congruence of information is the identification of exactly these criteria which are most suitable for the evaluation. Therefore, initially the attributes of information with an incomplete semantic congruence are identified, secondly the requests concerning the illustration of the parameters for describing and influencing the semantic congruence of information are formulated and thirdly the scientific findings proving the usefulness and the adequacy of the identified criteria are taken into account. In the second step a classification of five levels of fulfillment is developed for each of the identified criteria (see figure 1). Each of these five levels is described by a coherent statement which characterizes exactly that level of the criterion's fulfillment being achieved by specific information exchanged. For every single level a measured value is assigned which represents the quantitative evaluation of the respective criterion. The five levels of fulfillment for every criterion represent a metric. Merging the metrics of the identified criteria for evaluation the semantic congruence of information a partial instrument is built up which gives an overview of this semantic congruence as a whole. Additionally, out of the measured values dedicated to the levels of fulfillment of semantic congruence a formula was built up which represents a quantitative evaluation of the semantic congruence of information as a total. By implementing the partial instruments described above in a holistic proceeding the instrument for evaluating the semantic congruence of information is finally developed. This instrument consists of five steps starting from a qualitative evaluation of the semantic congruence of information and building up a profile representing this semantic congruence through a quantitative evaluation of the semantic congruence to a comparison of the evaluation results with a suitable reference profile representing a sufficient semantic congruence of the information.

The differentiation between complete and incomplete information requires a clear definition of information with a sufficient semantic congruence. The first step to this definition is building up the already mentioned system of decision-/task-combinations through the identification of kinds of decisions and tasks relevant in concurrent product development as described in the chapter above. In the second step characteristic minimum profiles representing a rudimentary, a developed and a sophisticated semantic congruence of information are defined. For this definition, the author uses a metric for evaluation the semantic congruence of information [14]. The evaluation of the semantic congruence of information is realized through the evaluation of the fulfillment of every single criterion characterizing this semantic congruence [1]. By marking the fulfillment of these criteria within the metric referring to the information available a profile is created representing the semantic congruence of this information. The third step contains the assignment of the defined characteristic minimum profiles of the semantic congruence of information to the system of decision-/task-combinations. This step is to make transparent how the minimum profile of the semantic congruence of information for specific kinds of decisions to be made within specific product development tasks has to look like. With reference to the assignment of the characteristic minimum profiles to the system of decision-/task-combinations in the final step the definition of a sufficient semantic congruence of information is given. This definition finally allows the differentiation between complete and incomplete information in concurrent product development.

4. EVALUATION INSTRUMENT

The evaluation instrument of the semantic congruence of information in concurrent product development consists of several partial instruments. Firstly, there are merged metrics for a qualitative evaluation of the semantic congruence of information. Secondly, measured values are derived from these metrics representing a quantitative evaluation of the semantic congruence of the same information. A visualization of the merged metrics leads to a characteristic profile representing the semantic congruence of these information. Thus, as a further element of the instrument there reference profiles representing a sufficient semantic congruence of information being exchanged in defined interaction scenarios must be made available. The specific interaction scenarios are led by the character of decisions to be made in context of specific tasks within processes of concurrent product development.

Criteria for evaluation

The identified criteria for the evaluation of the semantic congruence of information serve as the initial basis for the metrics explained. Each of these criteria is directly tied to one or more parameters for describing interactions. To give a definition of these criteria they are named and characterized as follows:

As the first criterion, the author identified the *fulfillment of the information needs* which characterizes the level of analogy of the contents of the information exchanged with the information needs. Thus, it evaluates the level of fulfillment the information needs by the information contents made available through an interaction. The suitability of this criterion is demonstrated by the existence of a similar criterion evaluating the value of information. This criterion is about the information logistics dimension *contents* representing the value of information in a given context [16].

The second criterion is named *fulfillment of the information characteristics* and defines the level of analogy of the characteristics of the information exchanged with the information needs. Thus, the criterion allows an evaluation of the suitability of the information characteristics for fulfilling specific information needs. There are several investigations and studies which identified the most important characteristics of information for specific purposes. The semantic congruence of information significantly is determined by the choice of exactly these information characteristics meeting the information needs, so the criterion named above is absolutely necessary for evaluating the semantic congruence of information.

The third criterion identified is the *transparency of the information needs* which characterizes the users' ability to identify the information needed for their own product development activities according to the contents and the characteristics of these information. The criterion includes the identification of suitable information objects as well. If no identification and no clear communication of the information needs can be realized an availability of exactly the information covering the contents and the characteristics needed can not be guaranteed so that there could be an incomplete semantic congruence of these information. The information needs results from the users' product development tasks and can be summed up as, so called, information profiles of the single organizations or actors [17].

The criterion *information ability* evaluates the ability of the information sources to make the needed contents and characteristics of information available through a specific interaction. Thus, there is an evaluation of the information sources' qualification as well as of their capability for cooperation and for making decisions. The criterion indicates the reliability and stability of the information supply. The suitability of this criterion is proven by the fact, that information about the author or the initiator of an information source are decisive factors for evaluating the information sources.

A further criterion is the *usability of the information objects* which supports the evaluation to what extent the information objects are able to make available the information necessary for making a decision during a product development process. If this ability can not be realized on an adequate level the information made available via the current information objects may not be usable for the decision. Thus, the information objects used are decisive factors for the specific information characteristics and, therefore, for the semantic congruence of the information exchanged.

The sixth criterion identified is the *fitting accuracy of the communication medium* which evaluates the ability of the communication medium used in an interaction to make the contents and characteristics of the information exchanged available. The choice of the information medium has rigorous impact on the contents and the characteristics of the information exchanged. E.g., the communications means *oral report* does not support the information characteristic *savable* sufficiently while the communication means *CAD file* does so. The better the communication means can transmit the contents and the characteristics of information the better the stability of the communication is and the better the availability and the quality of information exchanged are.

Finally, the criterion *ability for combination* evaluates the ability of the actors involved in an interaction to deal with gaps in the information exchanged efficiently and effectively. This criterion addresses the parameter *information users* and evaluates their experiences and their qualification which, in turn, influence the semantic congruence of the information. If the information users are skilled with a wide range of experiences and an appropriate knowledge spectrum and if they are able to combine these experiences and knowledge with the information exchanged also information with an incomplete semantic congruence can be used as a basis for making decisions or fulfilling tasks in concurrent product development. There is a strong coherency between data, knowledge and information [18] which demonstrates the suitability of the criterion named above. Similar to the criterion *information ability* the criterion *ability for combination* aims at an evaluation of the communication behavior by supporting the evaluation of the qualification and the abilities of the information users.

The seven criteria described above build up a sustainable basis for evaluating the semantic congruence of information. This estimation is based on the fact that these criteria are directly associated with each other as well as on the realized enquiry of exactly that factors that impact the semantic congruence of information substantially.

Metrics

Along the seven criteria for evaluating the semantic congruence of information metrics for a qualitative evaluation of the fulfillment of these criteria are developed which consist of five levels of fulfillment (see figure 1). For every single level of each criterion a characteristic statement was formulated which exactly describes the fulfillment of the particular criterion in words. Summing up, there is an amount of 35 statements presenting a characteristic profile of the semantic congruence of the information exchanged in the analyzed interaction.

Level of classification (qualitative grading of the fulfillment of a criterion for evaluation)	Very poor level of fulfillment	Low level of fulfillment	Medium level of fulfillment	Higher level of fulfillment	Complete fulfillment
Measured value (quantitative grading of the fulfillment of a criterion for evaluation)	1	2	3	4	5

Figure 1: Metric for evaluation the semantic congruence of information

Further more, every metric's level of fulfillment is tied with a measured value so that a quantitative evaluation of fulfillment the semantic congruence of the particular criterion can be given. By evaluating the semantic congruence of the information exchanged along every single criterion and by illustrating the results of this evaluation in a table bringing together these criteria characteristic profiles of the semantic congruence of the information exchanged are created. The developed metrics are characterized by consequently referencing to the contents and characteristics of information and addressing the parameters for describing information and communication structures, at the same time. With this background, distinguishing profiles presenting a rudimentary, a developed and a sophisticated semantic congruence from a holistic view are created.

Measured values

For the creation of the partial instrument which represents a quantitative evaluation of the semantic congruence of information the measured values tied with the respective criteria are merged. This merging is realized by a formula weighting the measured values depending on the importance of the criteria the single measured values are assigned to and summing up the weighting measured values to one total value for evaluating the semantic congruence of information. The importance of the single criteria was determined by a ranking of these criteria the author has deduced from the method called pairwise comparison [19]. The benefit of this method lies in its support of a ranking of given objects according to a distinct attribute which is applicable for all these objects – in case of the criteria defined above this attribute is the importance of these criteria for the evaluation of the semantic congruence of information.

The appliance of the pairwise comparison method results in highest ranks for the two criteria representing the core parameters for describing operative information and communication structures which are the fulfillment of the information needs as well as the fulfillment of the information characteristics. The further ranks are occupied by the criteria ability for combination, usability of the information objects and fitting accuracy of the communication medium. The two criteria information ability and transparency of the information needs take the last two ranks concerning the importance for the evaluation of the semantic congruence of information. Dependent on this ranking specific weighting factors are attached to these criteria so that formula merging the different measured values of these criteria to a total value is created. By using this formula a quantitative representation of the semantic congruence of information exchanged can be generated. A comparison of the total value resulting from an evaluation of the semantic congruence of information exchanged via an interaction within a concurrent product development process with the total value of the reference profile representing exactly the situation which actually is analyzed allows an estimation if the information exchanged can serve as a usable basis for the respective decisions to be made.

5. CLASSIFICATION OF THE INFORMATION

For building up the system of decision-/task-combinations as a basis for classifying information as complete or incomplete there are identified three kinds of decisions relevant within the business system product development. These kinds of decisions are called *decisions for or against*, *decisions of choice* and *variable decisions*. Within concurrent product development a *decision for or against* is defined as a decision for or against a fact concerning the developed product itself or the product development process. This kind of decision exists when only one alternative is available which can be realized or defaulted. Key criteria within decisions for or against are the costs and the benefits of the realization alternative. The *decisions of choice* are typical kinds of decisions within product development. They have to be taken between at least two alternatives which are excluding each other. The key criterion for the choice of one out of these alternatives is the proportion between costs and benefits which will be achieved by realizing the alternatives. The third kind of decisions, the *variable decisions* represent a specific kind of decisions of choice. These kind of decisions have to be taken on base of the experiences of an actor when there are given fuzzy alternatives.

Matching the two dimensions *kinds of decisions* and *kinds of tasks* leads to a system of decision-/task-combinations represented by a matrix. This matrix differentiates between the consequences of a decision on its first axis and the complexity of a task on its second axis. The first axis represents the consequences of a decision on the life cycle of the developed product. This dimension evaluates the life cycle costs of a product to be developed, the remaining time until the product development process is planned to be finished as well as the achievable quality of the product. The range of this dimension leads from a decision with little consequences up to a decision with extensive consequences on the product live cycle. The complexity of a task indicating the second axis of the matrix represents the difficulty of a task, its structure, its variability and its cross-linking with other tasks. This dimension ranges from a low level of complexity up to a high level of complexity of a task. The described decision/task matrix specifies delimited zones representing the fixed profiles of the semantic congruence of information (see figure 2). Depending on the position of a specific decision within this matrix combined with the position of the accompanying task this decision has to be made for there is a minimum semantic congruence of the information serving as a basis for this decision which has to be fulfilled.

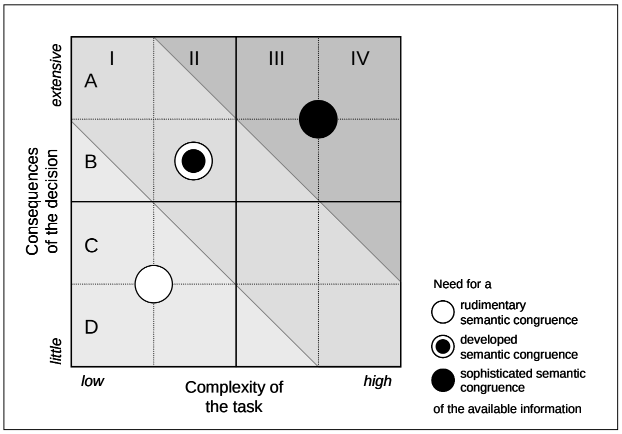

Figure 2: Matrix representing the system of decision-/task-combinations

To obtain a clear assignment of specific levels of semantic congruence to the possible decision-/tasks-combinations the author fixed the levels of a *rudimentary*, a *developed* and a *sophisticated* semantic congruence of information as characteristic. The definitions of these levels are based on the fulfillment of seven criteria characterizing the semantic congruence of information of which the two criteria *fulfillment of the information need* and *fulfillment of the information characteristics* have been identified as most important. Because of their high importance, the characteristic minimum profiles of semantic congruence require a higher level of fulfillment in the two criteria *fulfillment of the information need* and *fulfillment of the information characteristics* than in the remaining ones. Further more, these two criteria are charged with a doubled weighting compared with the other five criteria. Figure 3 gives a survey of the minimum profiles of a rudimentary, a developed and a sophisticated semantic congruence. The values in the single fields indicate the weighting factors for the seven criteria depending on the level of fulfillment of each criterion.

rudimentary semantic congruence — developed semantic congruence — sophisticated semantic congruence

	Level of fulfilment				
Fulfilment of the information need	2	4	6	8	10
Fulfilment of the information characteristics	2	4	6	8	10
Ability for combination	1	2	3	4	5
Usability of the information objects	1	2	3	4	5
Fitting accuracy of the communication medium	1	2	3	4	5
Information ability	1	2	3	4	5
Transparency of the information needs	1	2	3	4	5

Minimum measured value Mv_{min}: 22, 31, 40

Figure 3: Minimum profiles of semantic congruence of information

The assignment of these characteristic minimum profiles to the possible decision-/task-combinations results in a differentiated picture of the level of semantic congruence the available information at least has to obtain to serve as a suitable basis for a specific decision to make this decision a reliable one.

By classifying the identified kinds of decisions according to the consequences they have and the kinds of tasks according to their complexity into the matrix representing the system of decision-/task-combinations a rough preview of the necessary minimum profiles of the semantic congruence for all possible decision-/task-combinations can be given. E.g. the complexity of analysis tasks is evaluated as manageable and, thus, this kind of tasks are classified into column II of the decision-/task-matrix (see figure 3). Decisions for or against which have to be made within an analysis task are expected to have extensive consequences on the product life cycle. Thus, there is a classification of this kind of decisions in the context of analysis task into the upper part of line A of the matrix. Consequently, the semantic congruence of the information serving as a basis for such a decision must be sophisticated. To give a further example, variable decisions in context of analysis tasks mainly base on the experiences of the actors carrying out these tasks. Thus, the consequences of such a decision can be well calculated and, thus, they are classified as little. This means that variable decisions which have to be made within an analysis task are classified into line D of the decision-/task-matrix and that, consequently, there is only a need of a rudimentary semantic congruence to come to a decision.

On basis of the worked out results described in this paper a definition of a sufficient semantic congruence of information can be formulated. According to the statements of this paper, the minimum profile of rudimentary, a developed or a sophisticated semantic congruence which is assigned to a specific decision-/task-combination at least has to be met or passed to avoid wrong decisions and trial and error processes. From this insight the author gives the following definition of a sufficient semantic congruence:

The semantic congruence of information is sufficient if the profile representing the semantic congruence of the available information meets or passes the characteristic minimum profile necessary for a reliable decision of a specific decision-/ task-combination.

6. PROCEEDING THE EVALUATION

A structural processing of evaluating the semantic congruence of information as well as a classification of the information as complete or incomplete integrates three partial instruments:

Firstly, there are the metrics for the qualitative evaluation of the semantic congruence of the information exchanged from which a characteristic profile of this semantic congruence of this information is deduced. The second instrument is formed by the reference profiles representing a rudimentary, a developed, and a sophisticated semantic congruence of information according to the specific decisions to be made. Thirdly, the total value of the semantic congruence represents a further partial instrument of processing the evaluation of the semantic congruence of information.

Additionally to these instruments, there is the need for a methodical approach merging the different partial instruments and supporting a reliable qualitative as well as quantitative evaluation of the semantic congruence of information. This approach is represented by the following two phases of evaluation:

In the first phase an analysis of the product development processes is necessary to indicate the weak points of these processes and to identify the interactions causing the weak points. Subsequently, a complete image of these interactions with their information contents, information characteristics and communication agreements via the *Formal Interaction Analysis* [6, 7, 8] is drawn.

The second phase represents the actual evaluation of the semantic congruence of information concerning the respective interactions. Using the instruments described above, this evaluation bases on the preceding phase and covers five steps shown in figure 4.

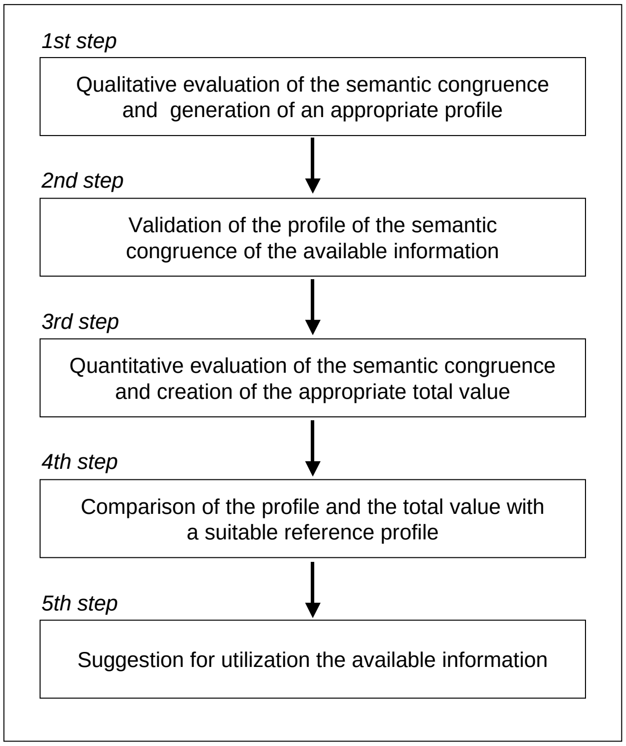

Figure 4: Steps for evaluation the semantic congruence of information

The five steps of processing the evaluation of the semantic congruence of information can be described as follows:

In the first step, the qualitative evaluation of the semantic congruence of the information exchanged within the interaction analyzed is carried out along the seven criteria described above. In doing so, for every criterion exactly the level of classification is chosen which represents the semantic congruence of the information exchanged. By transforming the seven identified levels of classification to a graphical illustration, finally, the actual profile of the semantic congruence of the information exchanged is created. This profile represents a holistic description of the main factors influencing the semantic congruence of these information.

The second step of evaluating the semantic congruence of information covers the validation of the actual profile and the realistic illustration of the semantic congruence of the information exchanged. The validation can be realized by different methods: E.g., a profile worked out in advance can be discussed with the actors involved in the analyzed interaction and adapted to their point of view. Alternatively, the actual profile of the semantic congruence of the information exchanged can be worked out by these actors themselves. The objective of the second step of evaluation is generating a users' view on the semantic congruence of the information exchanged and ensuring that this view represents a realistic illustration of this semantic congruence of these information.

In the third step, the total value of the semantic congruence of the information exchanged which is merged from the measured values of the single criteria of evaluating the semantic congruence of information is determined. This total value transforms the actual profile of the semantic congruence of information into a quantitative value which allows a quick gathering of this semantic congruence and points out eventual calls for action directly.

In the fourth step, the actual profile as well as the total value of the semantic congruence of the information exchanged is compared with the characteristic reference profile representing a sufficient semantic congruence of information and its appropriate total value represented by the system of decision-/task-combinations The choice of this reference profile depends on the specific character of the decisions to be made. The described comparison makes evident if the information exchanged achieve a rudimentary, a developed, or a sophisticated semantic congruence and if they would result in robust decisions to be made.

Finally, the evaluation of the semantic congruence of information will result in actions for improving this semantic congruence. Thus, suggestions how to handle the information made available within the analyzed interaction will be given. These suggestions can lie in a direct use of the information exchanged for the decisions to be made, they can lie in an improvement of the semantic congruence of these information before decisions are made and, finally, there can be suggested not to use these information but to wait until an improvement of these information is created by the information sources. When an improvement of the semantic congruence is suggested there are different alternatives for realizing this improvement which are another core result of the author's doctoral thesis.

7. CONCLUSION

The instruments described in the paper at hand support a qualitative as well as a quantitative evaluation of the semantic congruence of available information within an interaction on a very detailed level of a product development process. Further more, they allow a classification of information according to its completeness. They support the evaluation of the sufficiency or non-sufficiency of the semantic congruence of information available for a specific decision-/task-combination as well. If the semantic congruence of available information is evaluated as non-sufficient activities have to be initiated which improve this semantic congruence to create information with a sufficient semantic congruence.

The developed evaluation instrument visualizes the semantic congruence of information by presenting a profile of the actual semantic congruence. At the same time, this profile is transformed to a quantitative value represented by the total value extracted from the single measured values of the criteria for evaluating the semantic congruence of information. The instrument is completed by the procedure for evaluation of semantic congruence using the established metrics for building up the described profile as well as the formula for generating the total value describing the semantic congruence of information quantitatively. The evaluation instrument is only the base for the examination of information made available within interactions.

Based on the results of using the evaluation instrument, it is possible to describe a rudimentary, a developed, and a sophisticated semantic congruence of information represented by specific profiles and to attribute these profiles with defined total values of the semantic congruence of information. The system of decision-/task-combinations allows a classification of the information available as complete or incomplete. According to this instrument, information can be called as complete if their semantic congruence is sufficient to make a reliable decision within a specific product development task.

Depending on the results of using the instruments described, further more, a methodological improvement of the semantic congruence of information can be initiated if necessary. Summing up, the developed instruments build up a crucial base for the handling of information with an incomplete semantic congruence.

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