# Method Support of Information Requirements Analysis for Analytical Information Systems

## State of the Art, Practice Requirements, and Research Agenda

The development of analytical information systems differs from the development of transaction-oriented systems. Specific method support is particularly needed for requirements engineering. The paper at hand evaluates the state of the art in information requirements analysis and identifies areas for further research. From a practice perspective, a need for further research on information requirements elicitation, validation, and management can be identified. Furthermore, in order to ensure the ongoing elicitation, documentation, and management of information requirements, more effort has to be invested into the development of a continuous requirements process perspective.

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### 1 Introduction

In the domain of information systems, analytical information systems constitute an important group (Arnott and Pervan 2008; Elbashir et al. 2008). Unlike transaction-oriented systems, analytical information systems do not implement the automatable components of operational business transactions, but support decision making. The supported decisions show very different characteristics, ranging from decisions related to operational transactions (such as order acceptance, delivery scheduling) and the less standardized decisions of so-called "knowledge workers" (such as the design of sales promotion campaigns, further development of products/services) to strategic decisions (such as location decisions, decisions regarding the range of services, or the enterprise target system). Analytical information systems therefore represent a group of very heterogeneous information systems.

The goal-oriented design of information systems always requires a careful analysis and documentation of the particular requirements. Requirements engineering is understood as the sum of all activities which determine the requirements of an information system (component), document them, and keep them up to date. "The use of the word 'engineering' implies that systematic and repeatable techniques should be used to ensure that system requirements are complete, consistent, relevant, etc." (Kotonya and Sommerville 1998, p. 5). Since requirements engineering mostly deals with both business requirements and technical aspects of the system under development (Kotonya and Sommerville 1998, p. 19), these activities have a relatively high complexity.

For analytical information systems, the initially outlined high heterogeneity of decisions and end-user groups to be supported results in the fact that requirements analysis has a very high influence on the effectiveness of the solutions to be developed (Holten 2003; Prakash and Gosain 2008). Unlike transaction-oriented systems, where standardized, often repetitive business processes have to be analyzed in terms of automation potentials, analytical information systems require the elicitation, documentation, and management of information needs of different users or user groups for often less structured decisions (Jarke et al. 2000, pp. 4 ff.; Strauch 2002, p. 84; Winter and Strauch 2003): "...executive information requirements are different from operational requirements [...] IS professionals [have a] lack of adequate methodology to determine executive information needs" (March and Hevner 2007).

For analytical information systems, we distinguish informational and non-informational requirements. Informational requirements particularly focus on content, quality, and visualization of information, while non-informational requirements refer to, e.g., information system security, performance, data protection, and maintainability (Goeken 2005).

Since non-informational requirements for analytical information systems do not significantly differ from those of transaction-oriented systems, this paper focuses on informational requirements. The elicitation, documentation, and updating of informational requirements will be referred to as information requirements analysis (IRA) in the following.

In support of the IRA various methods have been proposed. Horváth (2006, p. 367) classified these methods as follows:

- Deductive methods (determination of the task-oriented, objective information requirements) vs. inductive methods (determination of the personal, subjective information requirements)
- Isolated method components (task analysis, document analysis, interview techniques, survey) vs. integrated methods

To integrate the various aspects of IRA for a specific subset of analytical information systems and to identify consistent requirements, (integrated) methods are frequently proposed. Examples of such methods proposals can be found in Krause and Schmitz (2006), Mayer (1999, pp. 119 ff.), or Strauch (2002, pp. 71 ff.).

However, as a result of the multitude and diversity of existing approaches, the knowledge base is difficult to access and comparatively low structured for practice, which is interested in the application of appropriate approaches, and science, which is dedicated to improving existing approaches. Hence, the aim of this paper is first to give a neutral overview of the state of the art in the field of IRA for analytical information systems.

Our research process is based on the process for review research as introduced by Fettke (2006, p. 260), which consists of the five phases "problem formulation", "literature search", "literature review", "analysis and interpretation", and "presentation". Following the formulation of the problem in this section, we will describe the selection of literature (literature search) and evaluate the approaches to be examined with regard to predefined criteria (literature review) in Sect. 2. Afterwards, Sect. 3 deals with the question of what requirements for an IRA method exist. Taking into account the requirements empirically derived from practice, Sect. 4 discusses which enhancement potentials can be identified ("analysis and interpretation"). The results are finally published in this article ("presentation").

## 2 Literature Analysis

In the following we present the results of the comparison and evaluation of the examined approaches. In Sect. 2.1 we first describe our literature selection approach.

### 2.1 Scope of Analysis

To identify relevant IRA approaches in scientific literature, we first carried out a keyword-based search in all journals of the years 1991–2009 which were rated with "A" by the scientific commission for business and information systems engineering (WKWI 2008). In order to also include the German-speaking business and information systems engineering, which is less represented in this group, additional journals from the German-speaking countries were included in the search (HMD, InformatikSpektrum). Due to its thematic relevance, we also included the "Journal of Requirements Engineering". As English-language keywords we used the term "information requirement" as well as one additional term related to analytical information systems ("management information system", "decision support system", "executive information system", "data warehouse", "data warehousing", "business intelligence", "OLAP") and – if applicable – the German-language translation of the term. As an exception, we also included the English-language contribution of Howard and Morgenroth (1968) in the literature to be examined. Although the date of this publication does not belong to the defined reference period, we consider the article to be a significant contribution to the topic under investigation due to its frequent citation. The keyword-based search itself was either carried out by means of the literature databases JSTOR, Sciencedirect, EBSCOhost (which have access to the above journals) or through the websites of the respective journals. Ultimately, we obtained a number of 90 articles in total. To increase the proportion of German-language publications, we carried out a backward search, such as proposed by Webster and Watson (2002), for the identified German-language articles. In this way, we could identify additional relevant contributions of German-speaking conferences. Overall, a number of 97 articles were identified, which was reduced to 30 articles in a subsequent step by selecting the contributions with a design-oriented character (development/ documentation of a process model, a reference model, a method, or the like as design goal) on the basis of an analysis of title or abstract.

### 2.2 Comparison and Assessment of the Approaches

The selected approaches were assessed on the basis of the established core activities of traditional requirements engineering based on Kotonya and Sommerville (1998) and Pohl (2008) as well as their sub-activities.

**Figure 1** provides an overview of the individual components and activities of requirements engineering in the form of a framework as developed by Pohl (2008, p. 39). This framework includes the system context, the core activities, the resulting requirement artifacts as well as the cross-functional activities validation and management. The system context provides the basic conditions of the IS to be developed and its requirements elicitation in the form of different facets that account for both the business perspective (domain facet, usage facet) and the technical perspective (information system facet, development facet). The core activities are *elicitation*, *documentation*, and validation of the requirements with regard to inconsistencies and interdependence (*negotiation*). Other cross-functional activities are the *validation*, ensuring the fit of the implemented functionality of the IS and the formulated requirements, as well as the *management*, i.e. the categorization, structuring, and maintenance of the requirements. The results of the core activities are the documented requirements ("requirement artifacts") in the form of goals, scenarios, and solution-oriented requirements.

In a study by Niazi et al. (2008), maturity levels of conventional requirements engineering approaches in companies are determined by means of a survey. The survey is based on an overview of the individual sub-activities of requirements engineering in the form of a questionnaire. Due to its systematic approach and its broad coverage we leverage this study for the evaluation of the literature approaches as well as for the design of the questionnaire used for the descriptive analysis in Sect. 3. Where necessary, we adapted individual aspects and variables of the questionnaire by Niazi et al.

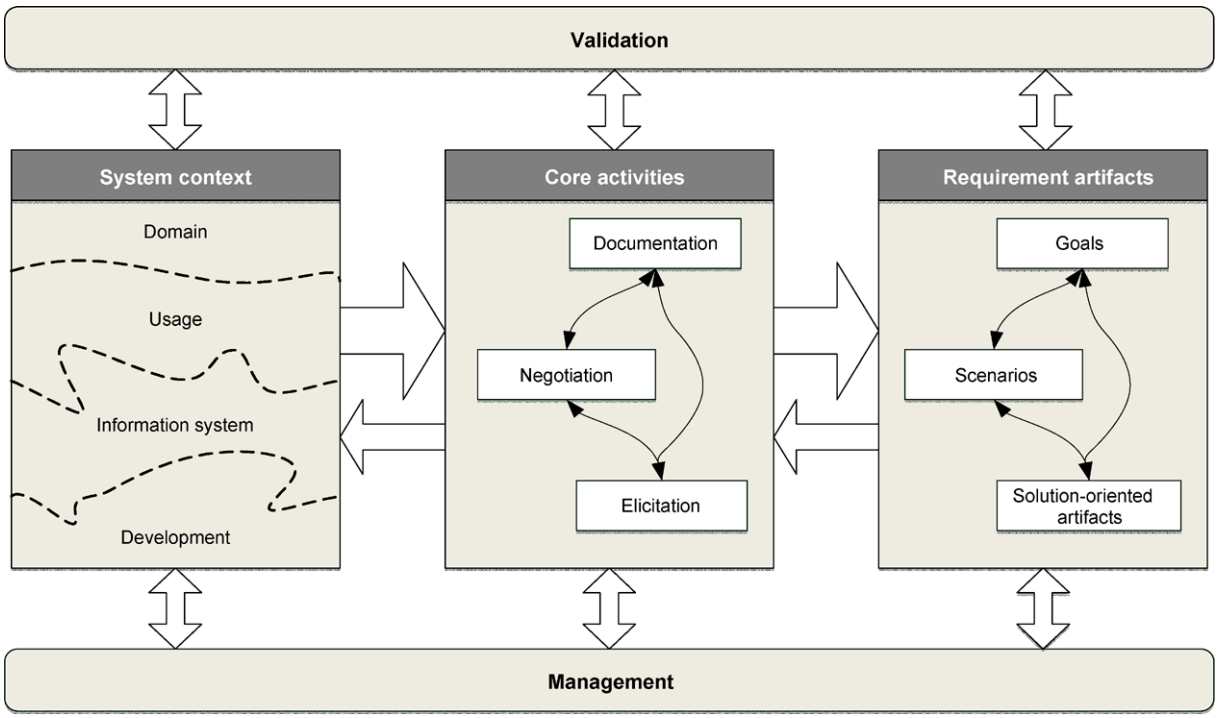



**Fig. 1** Requirements engineering framework (Pohl 2008, p. 39)

(2008) to the context of analytical information systems. Such a comparison allows us to analyze the extent to which existing IRA approaches are based on traditional practices in requirements engineering i.e., cover their activities.

In the following presentation of the results of the literature review in **Table 1** we omitted a detailed comparison of the 30 approaches and the plurality of sub-activities for reasons of improved readability and interpretation for the reader. Instead, we present the results in an aggregated form at the level of the core activities. In particular we describe to what extent the investigated approaches address the sub-activities or support them through the development of appropriate artifacts. For example, by studying the literature in the area of negotiation we could determine whether an approach considers the identification and removal of inconsistencies between requirements.

In addition to these purely content-based assessment criteria, the approaches were analyzed in terms of their methodical degree of support (criterion "method"). Furthermore, they were examined for whether reference models are presented as a design aid (criterion "model").

Moreover, we checked whether it is a generic or situational adaptable approach (criterion "situational aspects"). Fiedler's "contingency model" (1964) shows that there is not a single "best way" for the design of an organization's structure and processes. On the contrary, exogenous and endogenous factors have to be reflected according to which the solutions should be adapted ("contingent"). The need to explicitly adapt methods to the specifics of a particular application or usage situation is addressed by situational method engineering (Harmsen 1997; Kumar and Welke 1992; van Slooten and Hodes 1996).

Some of the selected approaches could be grouped together based on their thematic or personal similarity, thus enabling the representation to gain additional clarity for the reader.

**Table 1** summarizes the evaluation results. The evaluation ranges from approaches that fully cover the various sub-aspects of the described core activities (completely filled circle) to approaches that address none of the sub-activities (unfilled circle). Summing up the analysis, the following observations can be stated:

- The majority of contributions address the activity *elicitation* to an adequate or strong extent. Many of the approaches suggest that requirements elicitation should not only address employees with operational tasks, but also include those with middle management responsibilities and decision-making competence, such as department or team leaders. This shows that multi-perspective requirements elicitation is deeply integrated within these approaches. Furthermore, many of the examined publications aim at transparently deriving information needs from goal formulations.
- A similar number of approaches addresses the area of *documentation* of information requirements. However, only a few approaches deal with the problem of creating specifications of information requirements with a sufficient level of detail while at the same time making them easy to understand for both IT and business. This is of utmost importance if business users have to be interviewed for the validation of already documented information needs.
- The core activity *negotiation* is addressed by relatively few approaches. In particular, it is hardly described how the identified information needs should be prioritized. However, the prioritization of information requirements is an essential feature, e.g., of company-wide IRA approaches that determine a plethora of information requirements.
- Only a few approaches are concerned with the *validation* of specified information needs, e.g., in the form of

**Table 1** Overview and evaluation of the examined scientific approaches

● Completely covered ◕ Mostly covered ◑ Partially covered ◔ Somehow covered ○ Not covered n/a Not applicable

| | | Content-related aspects | | | | | Methodological aspects | | |
|---|---|---|---|---|---|---|---|---|---|
| Investigated approach | Description of the approach | Elicitation | Documentation | Negotiation | Validation | Management | Method | Model | Situational aspects |
| Becker and Knackstedt 2004; Becker et al. 2007; Holten 2003; Holten and Knackstedt **1999** | • Process model for the design of corporate reporting with four phases: initialization, actual state analysis, target analysis, and maintenance<br>• Automatic conversion of conceptually specified "management views" into logical data marts<br>• Use of configurative reference models in the development of conceptual models for analytical information systems | ◑ | ◔ | ◔ | ◑ | ◔ | ◑ | ◑ | ◔ |
| Bidgood and Jelley 1991 | • Development of an information architecture for the effective modeling of business and system-specific requirements<br>• Derivation of core activities (by decomposition of processes and analysis of data flow diagrams) and core entities as constitutive elements of an information architecture | ◑ | ◔ | ◔ | ○ | ◔ | ◔ | n/a | ○ |
| Bonifati et al. 2001 | • Method for the identification and design of data marts<br>• Support of the identification of needs by derivating business expectations with the help of a relation between goals, questions, and metrics<br>• Detailed specification of objectives in "abstraction sheets" for the transfer to star schemas or in fragments of a conceptual schema | ◕ | ◑ | ◔ | ◔ | ◔ | ◑ | n/a | ○ |
| Braunstein et al. 1991 | • Discussion of the problems in the collection of information requirements of decision makers<br>• Study of the problem areas mentioned in case studies and derivation of a prototyping approach for the determination of information requirements | ◔ | ○ | ○ | ◔ | ○ | ◔ | n/a | ○ |
| Burmester and Goeken 2005; Goeken 2004; Goeken 2005; Goeken 2006 | • Stakeholder-oriented identification and documentation of information needs and transfer of different viewpoints in one consistent view ("viewpoint resolution")<br>• Structuring of the requirements in information and decision-making objects in a conceptual schema and mapping of the schema with a logical data model | ◕ | ◑ | ◑ | ◑ | ◔ | ◑ | n/a | ○ |
| Calvanese et al. 2006 | • Development and implementation of a methodology to support the business design of a data warehouse<br>• Methodical approach based on a conceptual representation of the company both in connecting the required source systems as well as the structuring of the existing data in the data warehouse<br>• Support of conceptual modeling and data integration / data matching via prototyping | ◔ | ◑ | ◔ | ◑ | ◑ | ◑ | n/a | ○ |
| De and Sen 1984 | • Method for a systematic requirements analysis for database systems<br>• Event- and state-based modeling of decision processes to derive the required data and information | ◑ | ◔ | ◔ | ◔ | ◔ | ◔ | n/a | ○ |
| Giorgini et al. 2008 | • Requirements analysis for a data warehouse using an organizational or a decision-centered perspective<br>• Approach based on a purely demand-oriented or a combined demand- and supply-oriented procedure | ◕ | ◑ | ◔ | ◔ | ◔ | ◔ | n/a | ○ |
| Henderson and West 1979 | • Decision-oriented approach for the planning of management information systems<br>• Structured process to identify business-critical decisions and related information | ◑ | ◔ | ◔ | ◔ | ○ | ◔ | n/a | ○ |

**Table 1** (*Continued*)

● Completely covered ◕ Mostly covered ◑ Partially covered ◔ Somehow covered ○ Not covered n/a Not applicable

| Investigated approach | Description of the approach | Content-related aspects | | | | | Methodological aspects | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Elicitation | Documentation | Negotiation | Validation | Management | Method | Model | Situational aspects |
| Howard and Morgenroth 1968 | • Derivation of important information needs using an analysis of decision processes of managers in companies | ◑ | ◔ | ○ | ◔ | ○ | ◔ | ◔ | ○ |
| Kivijärvi 1997 | • Development of a business-oriented framework for the initial and continuous creation of enterprise-wide decision support systems<br>• Development of the framework based on different theories taken from management theory | ◕ | ◔ | ◔ | ◔ | ◔ | ◔ | n/a | ○ |
| Mayer 1999 | • Analysis of the strategic target system of the company and the identification and evaluation of individual strategic success factors<br>• Approach to derive the information requirements for strategic leadership ("method of strategic success factors") | ◑ | ◔ | ◔ | ○ | ○ | ◔ | n/a | ◑ |
| Munro and Wheeler 1980 | • Approach applied in a field study: Identification of business objectives, critical success factors, and information needs using existing planning processes | ◕ | ◔ | ○ | ○ | ○ | ◔ | n/a | ○ |
| Politano 2001 | • Description and discussion of techniques relevant to data warehousing projects in the context of requirements management: Entity-relationship diagrams, functional decomposition diagrams (including their use in the separation and derivation of topics for key figures) as well as CRUD matrices (Create, Read, Update, Delete) | ◕ | ◔ | ○ | ◔ | ◔ | ◔ | n/a | ○ |
| Prakash and Gosain 2008 | • Development of an organizational perspective with business objectives supporting the derivation of the necessary decisions and the resulting information needs<br>• Transformation of the organizational perspective into a technology perspective, which focuses on the content of the data warehouse | ◕ | ◔ | ◔ | ◔ | ◔ | ◔ | n/a | ○ |
| Schirp 2001 | • Discussion of critical success factors of projects for data warehouse requirements analysis, such as the design of the "data warehouse learning process", the distinction between planning and execution, and the integration of data warehouse maintenance | ◔ | ◔ | ○ | ◔ | ◔ | ◔ | n/a | ○ |
| Shanks and Darke 1999 | • Method for developing enterprise data models in the context of data warehouse systems<br>• Development of visualization mechanisms for improving the understanding of the models at the business side | ◕ | ◑ | ◔ | ◑ | ◔ | ◔ | n/a | ○ |
| Strauch 2002; Strauch and Winter 2002; Winter and Strauch 2003 | • Method for IRA with the phases requirements, actual state analysis, target analysis, functional specification<br>• Approach specified on basis of method engineering with descriptions of individual activities, techniques, and roles | ◔ | ◑ | ◔ | ◔ | ○ | ◕ | n/a | ○ |
| Volonino and Watson 1991; Watson and Frolick 1993; Watson et al. 2004 | • Method for determining the information necessary for the execution of key strategic processes ("strategic business objectives method")<br>• Development of organizational measures for continuous requirements management for data warehouse systems with definitions and descriptions of the required roles, among others | ◑ | ◔ | ◔ | ○ | ◑ | ◑ | n/a | ◔ |
| Wetherbe 1991 | • Discussion of selected reasons for non-compliance with information requirements of managers<br>• Presentation of solutions to address these problems, such as structured interviews, prototyping, etc. | ◑ | ◔ | ○ | ◔ | ○ | ◔ | n/a | ○ |

interviews with business users. Based on existing lightweight processes in software development (see e.g., Ebert 2008, pp. 70 ff.; Shore and Warden 2008, pp. 9 ff.), the increased integration of prototypes may facilitate the specification and, in particular, the validation of information requirements for analytical information systems. Nevertheless, there are hardly any IRA approaches that deal with prototyping.

- Despite the slowly but steadily evolving maturity of business intelligence or data warehousing applications in practice (Chamoni and Gluchowski 2004), only a few articles reflect the evolutionary character of analytical information system environments in companies. This is particularly evident from the fact that the continuous *management* of information requirements is hardly taken into account in the investigated IRA approaches. Design recommendations, such as requirements governance as part of IT governance as proposed by Watson et al. (2004), are almost entirely missing. IT governance, derived from corporate governance, aims to ensure the coverage of business objectives through IT in a coordinated manner by means of principles, practices, and role models (Meyer et al. 2003). According to Watson et al. (2004), the continuous identification and derivation of information requirements belongs to those topics which should be covered by governance through defined processes and roles.
- When analyzing *research methodology* it strikes that many of the studied approaches show characteristics of a method. However, there is a large variety with regard to the level of detail. Most approaches, for instance, do not provide a role or documentation model. Thus, these approaches can serve as a rough guidance, but not as a "blueprint" in the narrow sense. Almost all examined approaches have a strong generic character and do not allow adaptation to specific situations.

## 3 Requirements for a Methodical Approach to Information Requirements Analysis from a Practice Perspective

The findings from the literature analysis obtained in Sect. 2.2 form the basis for a discussion of possible enhancements of an IRA approach in Sect. 4. We complement these findings in the following by collecting requirements for a methodical IRA support empirically from the practice. Section 3.1 outlines the scope of this analysis and describes the structure of the questionnaire used as well as the basic conditions of the survey. In Sect. 3.2, we present and describe the obtained results from the survey.

### 3.1 Scope of Analysis

The analysis presented below aims at determining the currently prevailing actual state and targeted degrees of realization of critical sub-activities of an IRA for analytical information systems in practice. This allows for the derivation of requirements for a methodical approach from a practice perspective.

The structure and content of the questionnaire used for this purpose is based on the study by Niazi et al. (2008) – as it was already the case with the evaluation criteria for the literature review in Sect. 2. As a structural aid we in turn use the core activities of requirements engineering: elicitation, documentation, negotiation (consolidation), validation, and management. The detailed questions about the various core activities are also based on the work of Niazi et al. (2008) and were – where necessary – adapted to the context of analytical information systems. Each variable of the questionnaire is assessed by means of a five-point Likert scale (ranging from zero to four) in order to capture the current and the future desired degrees of realization (realization intentions).

The questionnaire was handed out to about 130 participants of a practice conference with a focus on "Data Warehousing and Business Intelligence" in the German-speaking area in March 2009. From the amount of 81 returned questionnaires, 25 were excluded due to incomplete or inconsistent statements. The resulting 56 records that could be used for further data analysis represent a response rate of about 43%. **Table 2** provides an overview of the industries the surveyed participants came from.

**Table 2** Composition by industry

| Industry | Composition in % |
|---|---|
| Banking | 29.1 |
| Software house and IT | 18.2 |
| Insurance | 12.7 |
| Other | 12.7 |
| Telecommunications | 7.3 |
| Manufacturing | 7.3 |
| Energy and water utilities | 5.5 |
| Retail | 3.6 |
| Public administration | 3.6 |
| Total | 100.00 |

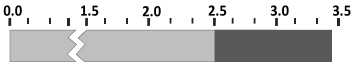
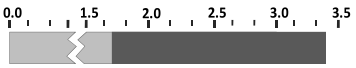
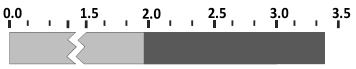
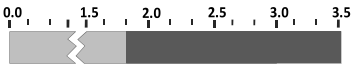
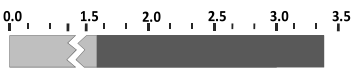
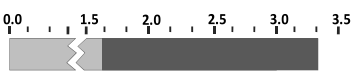
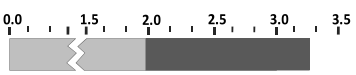
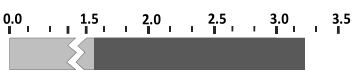
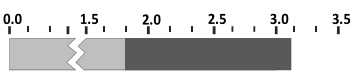
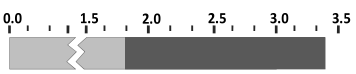
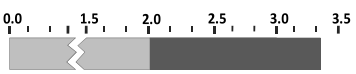
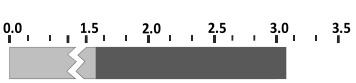
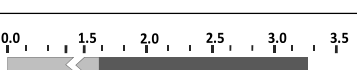
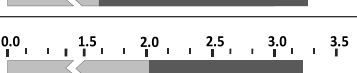
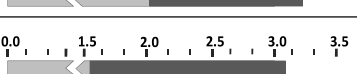
### 3.2 Evaluation of the Empirically Determined Results

In order to identify the key requirements for a methodical IRA approach from the perspective of practice, we classified the sub-activities within the core activities according to the average realization intention. **Table 3** shows the three sub-activities with the highest average values of the realization intention for each core activity. For each sub-activity the corresponding mean value of the realization intention (including standard deviation) and the deviation from realization intention and the actual degree of realization (including standard deviation) are shown. Furthermore, the degree of realization indicates the extent to which the particular requirement is already considered or used in the companies today.

In summary, for all sub-activities listed in **Table 3** significant differences between the current degrees of realization and the realization intentions within the IRA approach can be determined. Key aspects are briefly addressed below:

- In terms of *elicitation*, the surveyed companies aim at increasingly deriving information needs on the basis of middle management targets.
- As regards the *documentation* activity, increased demands for the comprehensibility of the documentation exist. Moreover, in order to avoid linguistic inconsistencies the desire is expressed

**Table 3** Requirements of practice

| | Variable (statement in the questionnaire) | Degree of realization (actual) (light grey) Deviation actual vs. target (dark grey) | Realization intention Mean value (target) (Standard deviation) | Deviation Target vs. actual Mean value (Standard deviation) |
|---|---|---|---|---|
| Elicitation | E1. In the elicitation of information needs, employees with middle management responsibility are interviewed (department heads, team leads). |  | 3.47 (0.50) | 0.97 (0.72) |
| | E2. In the elicitation of information needs, stakeholder objectives in dealing with the analytical IS are determined. |  | 3.43 (0.57) | 1.69 (0.94) |
| | E3. In the elicitation of information needs, future target requirements are taken into account. |  | 3.41 (0.50) | 1.45 (0.92) |
| Documentation | D1. In the documentation of information needs, the terminology (e.g., key figures) is defined to enable a consistent use of language (e.g., glossary). |  | 3.52 (0.57) | 1.67 (1.19) |
| | D2. In the documentation of information needs, the specification documents are understandable and readable for both the IT and the business departments involved. |  | 3.38 (0.62) | 1.78 (0.88) |
| | D3. In the documentation of information needs, the language used in the specification documents is accurate. |  | 3.34 (0.58) | 1.71 (1.04) |
| Negotiation | N1. Persons responsible for the source systems are asked about technical constraints in meeting the information needs. |  | 3.26 (0.58) | 1.28 (1.09) |
| | N2. Mutually dependent and overlapping information needs are identified (e.g., conflicting calculation of certain figures). |  | 3.24 (0.60) | 1.67 (1.23) |
| | N3. Documented information requirements are prioritized. |  | 3.12 (0.56) | 1.29 (1.01) |
| Validation | V1. The validation of the documented information requirements is based on interviews of involved staff from both IT and business. |  | 3.40 (0.59) | 1.57 (1.06) |
| | V2. The validation of the documented information needs is carried out through prototype implementation (e.g., reports) where appropriate. |  | 3.36 (0.64) | 1.34 (0.74) |
| | V3. The validation of the documented information needs is carried out by standardized documents which correspond to the company's internal standards (structure, content of the document). |  | 3.07 (0.59) | 1.50 (0.82) |
| Management | M1. A continuous management of information requirements is established. |  | 3.31 (0.62) | 1.71 (1.01) |
| | M2. Information requirements are recorded electronically (e.g., database, Excel file). |  | 3.28 (0.64) | 1.26 (1.00) |
| | M3. For the (subsequent) traceability of information requirements, a change history is maintained. |  | 3.12 (0.75) | 1.59 (1.12) |

to homogenize used terms (such as figures or dimensions) in the form of a glossary.

- In terms of *negotiation* there is an increased need for action with respect to the identification of mutual dependent or overlapping information needs (such as conflicting calculations of certain figures).
- From the perspective of the surveyed companies, also in the area of *validation* sub-activities, such as prototyping or validation by interviewing both business and IT, should receive more attention.
- Within the core activity of *management*, the establishment of a continuous management of information

**Table 4** Core activities and their average degrees of realization and deviation between actual and target state

| Core activity | Realization intention (target) | Realization intention (target) – degree of realization (actual state) |
|---|---|---|
| Elicitation | 3.15 | 1.32 |
| Documentation | 3.24 | 1.62 |
| Negotiation | 2.90 | 1.23 |
| Validation | 2.89 | 1.23 |
| Management | 3.15 | 1.55 |

requirements is claimed that should be facilitated and made transparent through the electronic elicitation and maintenance of requirements.

**Table 3** illustrates further differences and needs for action with respect to the sub-activities.

Moreover, the evaluation of the average realization intention and the average deviation of the degree of realization from the realization intention of the core activities (averaged over the respective sub-activities) indicates that there are still significant development potentials from the perspective of the practice in the areas of "documentation", "management" and "elicitation" (see **Table 4**). Although the core activities "negotiation" and "validation" are also generally perceived as important components, the need for action is considered less urgent from a practical point of view.

## 4 Enhancement Potentials of Existing Approaches

In the following sections, we first discuss the need for a fundamental distinction between an isolated project perspective and a continuous process perspective (Sect. 4.1). Based on this, Sect. 4.2 provides an overview of enhancement potentials of existing approaches based on the literature analysis (Sect. 2) and the need for action in practice (Sect. 3).

### 4.1 Project Perspective vs. Process Perspective

The core activities elicitation, documentation, and negotiation of classical requirements engineering are supported within a project by the cross-sectional activities validation and management (Pohl 2008, p. 39). In this respect, the management activity comprises, among others, the management and prioritization of requirement artifacts (goals, scenarios, individual requirements) in order to ensure the traceability of requirements, the creation of requirement packages ("requirement configurations"), and the observation of the system context (new legislative requirements, technologies, etc.) (Ebert 2008, p. 257; Pohl 2008, pp. 495 ff.). Often, the requirements engineering core activities – including the management activity – are tied to specific development projects (Pohl 2008, p. 35).

However, in some cases, this project-specific perspective should be extended by a process-driven, continuous component for requirements management. Thus, Pohl (2008, p. 35) introduces cross-project requirements engineering which "[is …] to be recommended when the projects of an organization often have a common subject matter". Analytical information systems in companies frequently relate to common subject areas with high dependencies between each other (e.g., between a data mart and a data warehouse). In addition, broad scope of content and users as well as long life cycles foster complexity. Kivijärvi (1997) describes the specificity of analytical information systems as follows: "Decision Support Systems […] are never be meant to be complete systems but they are expected to be under continuous modification, expansion, and movement, that is, in a state of continuous evolution." Accordingly, it appears useful especially in the case of an IRA for analytical information systems to also introduce the process perspective (in addition to the project view), which manages information requirements continuously and across projects. **Figure 2** illustrates the coexistence of the project and the process perspective.

The process perspective can be based on the sub-activities of the project-specific management. Furthermore, it can leverage key approaches, such as prioritization, the composition of requirement packages, or the inclusion of modified requirements (versions). For the coordination of these activities appropriate processes and roles are required (governance, see Sect. 2.2). These define the division of tasks and responsibilities between the project and the cross-project process.

### 4.2 Consolidation and Analysis of Enhancement Potentials

As described in Sect. 1, this article aims at systematizing existing scientific IRA approaches and to derive substantive extensions to the development of a methodical IRA approach. In the consolidation and discussion of possible enhancement potentials, we also consider the results of the practice survey as presented in Sect. 3. Below, we first address the core activities bearing the greatest need for action from a practice perspective (see **Table 4**).

One of the expandable aspects is the *documentation* of information needs. In practice, there is a strong need for models and documentations that can easily be understood by business and IT, without, however, losing precision in the specifications (see top requirements D2 and D3 in **Table 3**). Kivijärvi (1997) presents a framework that on the one hand represents a functional hierarchy of a company and on the other hand illustrates company-external influences on the analytical information requirements of the company. However, one problem here is the low level of detail. While it allows an overview of company-wide IRA approaches for analytical information systems in one step, the level of detail is too coarse-grained for the development of an information system.

Howard and Morgenroth (1968) focus on the modeling of decision-making processes in their approach. The resulting process models can generally be understood not only by a company's IT departments, but also by business users. In the course of an IRA, business users are often interviewed in terms of the validation of models and specifications and should therefore manage with these types of results. The authors describe the processes in sufficient detail so that the data or information necessary for executing the processes can be derived. However, decision-making processes that make use of analytical information systems are often very unstructured so that modeling these processes is very difficult (Strauch 2002).

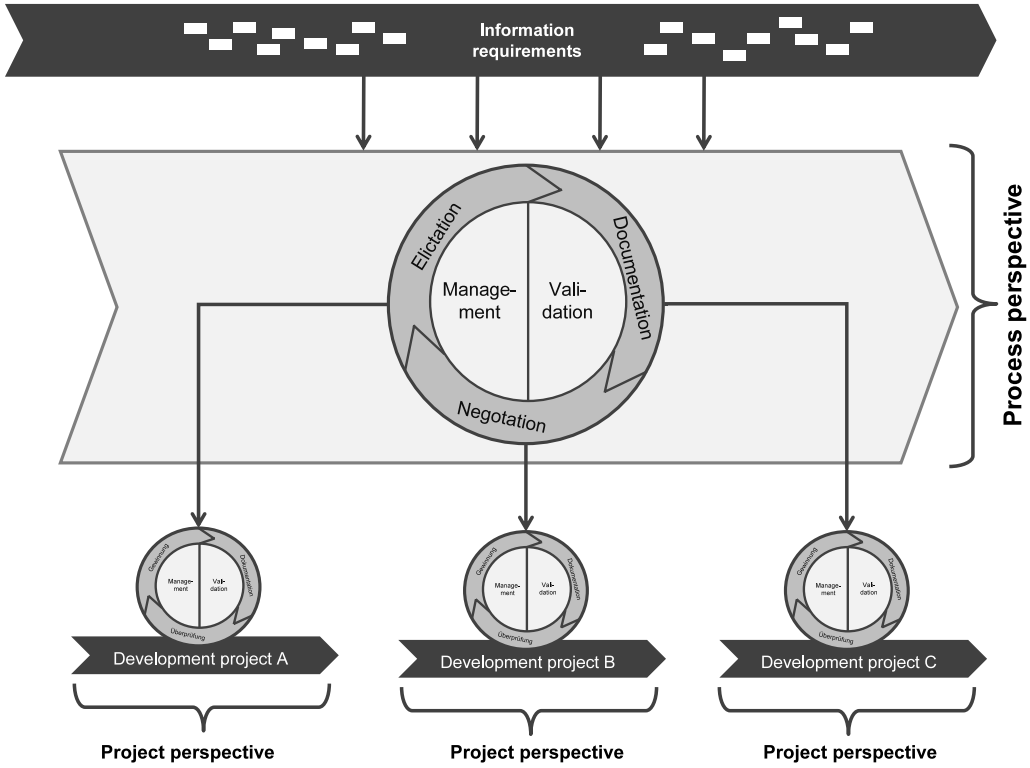



**Fig. 2** Process perspective and project perspective (based on Pohl 2008, pp. 35, 39)

Bidgood and Jelley (1991) address this challenge and in their contribution provide the concept of an information architecture, which is understood as a tool for determining the information needs existing in companies. Here, the main activities of the business are compared with the required information. Bidgood and Jelley (1991) consider it essential to develop an information architecture with a sufficient and manageable level of detail, which is effectively aligned with the targets of the business departments, and can be created at a reasonable expense.

An information architecture should provide the opportunity to represent the satisfaction of analytical information supply and the information needs of the individual organizational units at an aggregate level and company-wide. If it is equipped with these properties, an information architecture may also support the management of information requirements. For example, the information architecture can be used as a tool to transparently perform and represent the prioritization of information needs and to communicate within the company in a target manner (see results in **Table 3**). If problem areas in terms of analytical information supply are identified during the analysis, a more fine-grained analysis can be carried out for the corresponding areas and information requirements can be captured in a level of detail that enables subsequent information system design (Goeken 2006, p. 394). The "right" level of abstraction can be regarded as a success factor for the long-term use of such an architecture: "When producing an information architecture, analysts should avoid too much detail: entities and activities identified should be relevant at the enterprise level, not merely the department level" (Bidgood and Jelley 1991).

In addition to the information architecture as a tool for the continuous *management* of the information requirements, the governance structures and processes necessary for that purpose should be determined – which is occasionally (e.g., Goeken 2006, p. 396) also claimed in the literature. The objective is to enable the business departments to communicate their information needs (and low-level, non-informational requirements) in a simple way to the organizational units on the IT side. The recorded requirements should be managed centrally and should be continuously integrated in the planning for the design and adaptation of analytical information systems – a claim which is to be found several times in practice, as top requirement M1 (see **Table 3**) shows.

In Watson et al. (2004), for example, the authors describe the functionality of so-called "business requirements groups" as well as their integration into a data warehouse organization. A classification of system adaptation types, as found for example in Kivijärvi (1997), may provide recommendations for the systematic derivation and design of continuous management processes for information needs.

The *elicitation* of information needs seems to be relatively well covered in the literature. However, it can be seen from the practice survey that in this field companies still mention a considerable need for improvement of their applied practices (see top requirements E1–E3 in **Table 3**). A major reason for this may be seen in the lack of direct methodical applicability of existing IRA approaches.

From the perspective of practice, there is less need for action with regard to the core activities of validation and negotiation (see **Table 4**). Yet even here enhancement potentials can be identified:

In the process models of the concepts by Goeken (2004, 2005, 2006), Holten et al. (2003, 1999), or Shanks and Darke (1999) the issue of *validation* is indeed

## Abstract

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### Method Support of Information Requirements Analysis for Analytical Information Systems

**State of the Art, Practice Requirements, and Research Agenda**

Due to specific characteristics of analytical information systems, their development varies significantly from transaction-oriented systems. Specific method support is particularly needed for requirements engineering and its information-related component, information requirements analysis. The paper at hand first evaluates the state of the art and identifies necessary method support extensions. On this basis, method support requirements for information requirements engineering are identified. The survey is structured along the five core activities of traditional requirements engineering. It reveals a need for further research especially on information requirements elicitation, validation, and management. It further contributes to a discussion of aspects that should be considered by any method support. Due to comparatively long life cycles of analytical information systems, the introduction of a process perspective is discussed in order to ensure the continuous elicitation, documentation, and management of information requirements.


**Keywords:** Information requirements analysis, Analytical information systems, Data warehousing, Business intelligence, Method engineering

addressed as an important component of information requirements analysis. However, the authors only partially address iterative and agile approaches. Both approaches are rooted in requirements engineering and are particularly used if requirements are unknown and perhaps can only be specified in the course of system development (Ebert 2008, p. 71). Here, prototyping usually is the elementary concept, which, however, is analyzed to a greater extent and in the context of analytical information systems only in some of the contributions examined in Sect. 2, such as in Wetherbe (1991) or Shanks and Darke (1999). It is clear from the survey presented in this article, for instance from the identified top requirements V1 and V2 (see **Table 3**), that the practice claims a further increased interaction between IT and business departments in this field as well as intensified use of prototype implementations and approaches. In particular through the variety of presentation and preparation options of analytical information (e.g., in the form of dashboards, standard reports, OLAP cubes, etc.), prototyping with a strong involvement of the "customers", i.e., the system users, appears to provide a huge degree of freedom which should be sufficiently considered and supported by an IRA approach.

As regards the core activity of the *negotiation* of information needs, the investigated approaches neglect important aspects, such as the prioritization or consistency checking of informational requirements, and also offer relatively low methodical support in this context.

## 5 Conclusion and Outlook

The paper at hand consolidates requirements for a methodical IRA approach for analytical information systems. On the one hand, we conducted a literature review in the IRA context. On the other hand, we empirically collected requirements for an IRA approach from the perspective of practice. According to the relevance paradigm of design science, unresolved aspects result from the delta between the requirements mentioned in practice and the capabilities of existing scientific approaches that must be included in a further development of a methodical IRA approach.

It appears that existing, thematically related approaches address a variety of necessary activities, but ignore some aspects in the areas of documentation, management, and validation. The existing approaches offer methodical support in the sense of providing impulses. Thus, they cannot be understood as a "blueprint" in the narrow sense. Moreover, the approaches have a very generic character and do not support the adaptation to specific situations. The requirements collected in the course of a practice survey show that in the context of documentation and elicitation as well as in case of the management of information needs there is a particular need for action. The synthesis of the literature analysis and the survey first results in the fact that a project- and a process-specific view are useful in the IRA context. On the basis of this distinction, we then identified specific content-related enhancement potentials, indicating current research needs.

Further research needs also particularly arise on the basis of the identified methodical enhancement potentials. Specifically, this refers to the development of a situational IRA method and thus the further development of the illustrated, non-situational approaches (see Sect. 2.2). The large heterogeneity of analytical information systems suggests that no IRA method can be appropriate for all kind of systems. Situational methods provide adaptation mechanisms to address exogenous and endogenous factors of a problem area and can therefore be adapted to the specifics of the particular application or usage situation. In order to develop a situational IRA method for analytical information systems, it is necessary to identify the endogenous and exogenous factors and the resulting IRA situations first. Based on the knowledge of the IRA situations, a method has to be devolved that is adaptable with regard to important IRA situations, i.e., a method that addresses the relevant factors in an appropriate way.

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