Towards Improving Structure and Content of Information Demand Patterns

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Abstract. Work presented in this paper originates from the field of information logistics and aims at the reduction of information overload. Among the approaches for reducing information overload, the concept of information demand patterns (IDP) was developed for capturing organizational knowledge on how to improve information flow in enterprises. The paper investigates how the structure of IDPs is perceived by potential users and which enhancements of the structure could be made for improving content and quality of IDPs. For this purpose, an investigation including two steps is performed. The first step involves students in a university course who apply the IDP structure for developing IDP candidate descriptions. The intention is to explore whether the IDP structure reached a level of maturity to transfer it to non-experts in the IDP field. The second step evaluates the IDP developed by the students with respect to the quality of the different parts of the IDP structure. The conclusion of the investigation is that the IDP structure in general is applicable and useful, but consistency between the different IDP parts needs to be improved by providing aids and guidelines.

Keywords: Information demand, information demand pattern, demand modeling, validation.

1 Introduction

Work presented in this paper is a contribution to the field of information logistics, which aims at improving information flow in enterprises and organizations [1]. The general intention is to contribute to reducing information overload, which more and more is perceived as problem in enterprises [2]. Among the many approaches for achieving a more demand-oriented information supply, modeling and analysis of information demand have been proposed [3] and the concept of information demand patterns has been developed. Information demand patterns are considered as a way of capturing organizational knowledge about what information is required for specific roles in an organization.

Application and validation of information demand patterns so far was based on industrial case studies, like in collaborative engineering [4], and surveys in higher education [7]. This paper aims to extend work on information demand patterns by addressing the aspect of how to improve the inner quality of information demand patterns, i.e. the completeness, accuracy and pertinence of the pattern content, which is structured into different parts. For this purpose, an investigation including two steps is performed. The first step involves students in a university course who apply the IDP structure for developing IDP candidate descriptions. The intention is to explore whether the IDP structure reached a level of maturity to transfer it to non-experts in the IDP field. The second step evaluates the IDP developed by the students with respect to the quality of the different parts of the IDP structure. The main contributions of this paper are (1) results from validating the concept of information demand pattern in a university course, (2) results from evaluating the different parts of information demand patterns regarding their quality and (3) conclusions how to improve the concept and structure of IDP.

The remaining part of this paper is structured as follows: section 2 describes the background for the work by introducing the concept of information demand and information demand patterns. Sections 3 and 4 contain the two-step investigation performed: Section 3 focuses on the first step of the investigation, i.e. the set-up, data collection and results of applying IDP in a university master course for developing IDP candidate descriptions. Section 4 covers the second step of the investigation, which is a quality assessment of the different parts of the IDP candidate descriptions produced in step one. Section 5 draws conclusions and presents an outlook on future work.

2 Background

Work on understanding the nature of information demand and on identifying and structuring patterns of information demand form the background for this paper. This background will briefly be summarized in this section. Furthermore, the section summarizes the results of a previous IDP validation exercise performed in higher education in 2010 (section 2.3).

2.1 Information Demand

The notion of information demand is closely related to work in the area information logistics, which considers understanding information demand as key aspect of information logistics solutions [4]. Information demand usually includes different dimensions, like the content required, the time of delivery, the location, the presentation and the quality of information. The research field information logistics explores, develops, and implements concepts, methods, technologies, and solutions for the above mentioned purpose.

Lundqvist explored the nature and characteristics of information demand in an enterprise context in an empirical investigation [5]. The conclusion from the study is

information demand of employees in an organization is to a large extent based on the organizational role and the tasks an employee has. This role-centric perspective with tasks and responsibilities as primary characteristics has been the starting point for developing a method for information demand analysis [3].

Lundqvist defines information demand as: "*Information demand is the constantly changing need for relevant, current, accurate, reliable, and integrated information to support (business) activities, when ever and where ever it is needed." [5, p. 61]*

2.2 Information Demand Patterns

The concept of information demand pattern originates from work in the research and development project Information Logistics for SME (small and medium-sized enterprises) (infoFLOW). infoFLOW included seven partners from automotive supplier industries, IT industry and academia. The objectives were to develop a method for information demand analysis [6] and to identify recurring elements in information demand, i.e. patterns of information demand. The general idea of information demand patterns (IDP) is similar to most pattern developments in computer science: to capture knowledge about proven solutions in order to facilitate reuse of this knowledge. In this paper, the term information demand pattern is defined as follows: *An information demand pattern addresses a recurring information flow problem that arises for specific roles and work situations in an enterprise, and presents a conceptual solution to it*.

All information demand patterns are supposed to have a uniform structure, which consists of a number of essential parts used for describing the pattern:

- The *pattern name* usually is the name of the role the pattern addresses.
- The *organisational context* explains where the pattern is useful by identifying the application domain or the specific departments or functions in an organisation forming the context for pattern definition.
- The *problems* of a role that the pattern addresses are identified. The tasks and responsibilities a certain role has are described in order to identify challenges and problems, which this role usually faces in the defined context.
- The *conceptual solution* describes how to solve the addressed problem. This includes the *information demand* of the role, which is related to the tasks and responsibilities and usually consists of different elements; *quality criteria* for the different elements of the information demand, like the importance of accuracy, completeness and timeliness; the *timeline* indicating the points in time when the different information demand elements should be available.
- The *effects* that play in using the proposed solution are described. If the different elements of the information demand should arrive too late or are not available at all this might affect the possibility of the role to complete its task and responsibilities. Information demand patterns include a description of potential economic consequences; time/efficiency effects; effects on increasing or reducing the quality of the work results; effects on the motivation of the role responsible; learning and experience effects; effects from a customer perspective.

The above parts of a pattern are described in much detail in the *textual description* of the pattern. Additionally, a pattern can also be represented as a *visual model*, e.g. a kind of enterprise model. This model representation is supposed to support communication with potential users of the pattern and solution development based on the pattern. An example for an actual pattern for the role of "Material Specification Responsible" in a manufacturing enterprise can be found in [4].

2.3 Validation of IDP in Higher Education

As a contribution to increasing the maturity of IDP, a validation activity was performed in 2010 in the context of higher education [7]. We investigated the use of information demand patterns in higher education by performing an exercise with 22 students divided into 12 groups in a master course on information logistics. The intention was to explore whether the IDP structure has reached a level of maturity to transfer it to actors outside the development team and whether it also can be applied for capturing information demand in general. The exercise consisted of a practical task and a questionnaire designed to capture experiences and impressions of the students. The practical task was to describe the information demand for a task or a role, where the students felt that they are experts or have at least a lot of experience.

The main result of the validation activity was that the respondents participating in the exercise managed to produce information demand descriptions using the pattern structure, which indicates that they understood the structure as such and were able to apply it. The work also resulted in some proposals for improving the IDP structure, e.g. by putting more weight on actual information sources, and in improving the way of teaching information demand modeling, e.g. by spending more efforts on enterprise modeling aspects such as role modeling. These recommendations were implemented in the IDP structure and taken into account in teaching activities.

3 Study on Development of IDP Candidate Descriptions

In order to improve the maturity of IDP structure introduced in section 2.2, a two-step investigation was designed focusing on the "inner" quality of information demand patterns, i.e. the completeness, accuracy and soundness of the different parts of a pattern (e.g. context, problem, information demand, effects, etc.). The first step introduced in this section basically is a repetition of the validation exercise presented in section 2.3 in a different context: again, students in a university course are asked to apply the IDP structure for developing IDP candidate descriptions. The intention of this repetition is twofold: we wanted to confirm the result of the first exercise that the pattern structure can be applied by non-experts in the IDP field and we wanted to create a larger sample applicable for the second step of the investigation, which focuses on the quality of the different parts of the IDP structure and is presented in section 4. The remainder of this section describes the set-up for the investigation, shows selected results of the data collection and compares the results with the previous validation exercise.

3.1 Set-up for Data Collection

The data collection was performed in an exercise within the above mentioned master course in Riga, Latvia. The information system development course was attended by 18 students. The participating students did their bachelor degree in Riga. As a preparation for the exercise, the students were introduced in several sessions into the area of information logistics on basic principles of information logistics, demand modeling approaches and typical applications. This included an introduction to the concept of information demand pattern including examples. This initial introduction into the field of this work was essential to increase the validity of this work.

Afterwards, the students were given an exercise consisting of a practical task and a questionnaire to be filled in after the practical task. The students had to accomplish the task on their own, which resulted in 18 solutions handed in. The task was introduced by the teacher, but there was no further guidance provided during the work on the exercise.

The practical task was to describe the information demand for a task or a role, where the students felt that they are experts or have at least a lot of experience. They were encouraged to consider different areas when deciding on the task or role they want to describe, including their private or social background, the university context or any other field. The description of the information demand had to be structured like an information demand pattern (see section 2.2). A template was provided for this purpose as well.

The questionnaire included 9 different questions, four of them with a five-point Likert scale, one with a nominal scale, one with an interval scale and three for free text answers.

3.2 Data Analysis

All 18 students, which in the following will be called respondents, submitted information demand descriptions following the pattern template and all filled in the questionnaire. The information demand descriptions addressed the following subjects:

- Human resources manager
- Client / credit manager
- Employee of logistics department
- Data update responsible
- Automation of scheduled request output saving in project accounting module
- Responsible for warehouse operations
- Responsible for coordination of audit project team
- Responsible for organizing a team building event
- Responsible for cleaning clothes
- Business visionary
- Bus terminal accounting software administrator
- Helpdesk employee
- Website editor
- Responsible for online shop

- Change administrator
- Change administrator for game software
- Administrator for server load balancing

In the questionnaire, the respondents were asked whether the elements in the IDP structure are needed in order to describe information demand or whether there are superfluous elements. Sixteen respondents answered that all elements are needed, two of them responded that one element – timeline – was not needed.

When asked whether anything is missing in the IDP structure, two respondents demanded: more visualization of information to understand the pattern easier and an appendix to provide more information about filling in the pattern in detail. The other sixteen students considered the structure as complete.

Table 1. Response distribution for "How difficult to *identify* were the different parts?".

Element of IDP structure	Very difficult	difficult	Neither difficult nor easy	easy	Very easy
Context	1	2	9	4	2
Problem	1	3	10	2	2
Tasks/responsib.	1	2	12	3	
Info demand	1	9	7	1	
Quality Criteria	3	8	6	1	
Timeline	2	3	7	6	
Effects	1	9	6	2	

When asked "How difficult to *identify* were the different parts of structure?", the following distribution of answers was observed (see table 1). This distribution follows in most rows the Gaussian distribution. The information demand, quality criteria and effects are believed to be more difficult than the other elements of the IDP structure.

The question "How difficult to *describe* were the different parts of structure?" resulted in the following response distribution (see table 2). Again, most of the responses follow Gaussian distribution with exception of one aspect. To describe the effects of receiving information too late or not receiving is considered difficult by half of the participants. As seen one participant did not answer this question.

Table 2. Response distribution for "How difficult to *describe* were the different parts?".

Element of IDP structure	Very difficult	difficult	Neither difficult nor easy	easy	Very easy
Context		3	10	3	1
Problem		5	9	2	1
Tasks/responsib.	1	2	9	5	
Info demand	1	5	8	3	
Quality Criteria	2	5	7	3	
Timeline		3	8	6	
Effects	1	7	6	3	

Regarding the aspect "How much time was needed to identify and describe the different parts?", table 3 shows the distribution of responses. Here, describing the information demand was considered the most time consuming activity, as 51% of the respondents answered that "very much" or "much" time was needed. Describing quality criteria and effect also were considered time consuming by roughly 47% of the respondents.

Table 3. Response distribution for "How much time was needed for the different parts?".

Element of IDP structure	Very much	much	Neither much nor little	little	Very little
Context	1	5	9	3	
Problem	1	5	9	3	
Tasks/responsib.	1	5	9	2	
Info demand	1	9	7	1	
Quality Criteria	2	8	7	1	
Timeline		4	7	5	2
Effects		8	7	1	1

When it comes to the time needed to develop the information demand description, the field is located close to each other except one participant needing more than 12 hours (see table 4).

Table 4. Response distribution for the overall time needed for completing the exercise.

Time needed	Number of responses
less than 2 hours	
2 hours – 4 hours	8
4 hours - 6 hours	7
6 hours - 8 hours	2
8 hours - 10 hours	
10 hours - 12 hours	
More than 12 hours	1

3.3 Discussion

The main conclusion from the performed exercise is that there are clear indicators to believe that

- the respondents understood concept and structure of information demand patterns and were able to apply it on their own, and
- the structure proposed for information demand patterns is also suitable for describing information demand in general.

Both conclusions are supported by the fact that 18 complete information demand descriptions for different tasks or roles were developed by the participants in the exercise without guiding or supporting them in the actual development process of

these demand descriptions. This indicates that the students learned how to use the information demand pattern structure for capturing information demand descriptions. The pattern structure was judged suitable and complete by the clear majority of the students. The weight of these observations is relatively low due to the limited experience level of the students, but nevertheless contributes to the validation of the IDP concept.

The list of developed information demand descriptions shows a wide bandwidth from more socially oriented tasks (like "organizing a team building event") to strictly business-oriented ("human resources manager") or IT-oriented roles (e.g. "administrator for server load balancing"). The quality of these patterns was only evaluated by the teaching team in the course who checked the consistency between the different parts of the description, the understandability of the different textual elements, the completeness of the description, and whether the descriptions were sound and reasonable. This "perceived" quality of the patterns might be sufficient as initial check, but would have to be complemented with an "in-use" check of the description, i.e. applying them in a real-world situation for performing the task/role under consideration.

With respect to the perceived quality, the impression was that those patterns who addressed quite small and very specific roles or tasks were the better ones. Examples are "organizing a team building event" or "responsible for cleaning clothes". Furthermore, it was observed that some of the business related demand descriptions were very detailed and high-lighted interesting challenges. An example is the "helpdesk employee", which was reflecting a lot of experience, since the respondent developing it had several years of job experience on this position from his time before starting the master education. Thus, the results of the exercise also include some information demand descriptions, which can be considered as candidates for future information demand patterns.

The answers from the questionnaire regarding difficulty and time needed to identify and to describe the different elements of a demand description can be used as basis when improving the exercise and the course on information logistics. More emphasis in next year's teaching should be put on repeating organizational concepts like "role" and "task" and how to actually describe them in a proper way. This is in line with the conclusion from the study performed in 2010 [7].

Furthermore, the quality of the information demand descriptions probably could be improved by several measures. One aspect could be to add more examples for information demand patterns and perform the stepwise development together with students in order to improve the understanding of the concept and the different elements of an IDP. Furthermore, the evaluation of the patterns could be made part of the course, by providing a guidance for the evaluation process and letting the students evaluate another group's demand description.

When evaluating the free form questions of the questionnaire, an interesting observation surfaced: the students had to learn that they really have to be experts in the domain in order to be able to describe the information demand. More than half of the groups indicated that the hardest task in the exercise was to scale down the role or task under consideration to a scope which really reflected their own area of expertise.

3.4 Conclusions from the first investigation step

The results of the investigation done in Riga have been presented in section 3.2 and have been discussed in section 3.3. It is clearly to see that most of the achieved results are very similar to the first investigation done in 2010. The results of the first investigation are confirmed. Some noticeable differences will be discussed in the following.

The students in Riga needed less time to accomplish their task filling out the information demand pattern template than the students from the first investigation done in 2010. A possible explanation is quite simple because the teacher in the 2010 study accepted the pattern only after having a look at the pattern handed in. Therefore some pattern descriptions were given back to the students in order to improve the quality.

Noticeable is as well that information demand and effects were the parts which were most difficult to identify and to describe. Furthermore information demand and effects were the most time consuming part of the pattern. A relation between time an quality can be supposed.

As shown above this study was useful to confirm the result from the first study. The IDP pattern can be applied by non-experts without further guidance, but was not suitable to indicate how to improve the pattern quality.

Therefore one more investigation step is needed, which is described in section 4.

4 Quality Assessment of the IDP Candidate Descriptions

As illustrated in section 4 both exercises were performed in order to get indications about the usability of the IDP concept by non-experts in the field and about where improvements would be recommendable. Starting from the results presented in 3.3 and 3.4 we decided to investigate in more detail why participants perceive the parts “information demand” and “effects” as more difficult as the other parts. An interesting question in this context is, whether the quality of the “information demand” description and the “effect” description is worse than the quality of the other parts and the overall pattern, since the respondents consider these two aspects as more difficult. If this conjecture could be confirmed, more efforts should be spent on supporting the developers of IDP descriptions with respect to these two aspects: information demand and effects. This section describes how this second step of our investigation was performed, what results were achieved and which conclusions to draw.

4.1 Data Collection Process

As already pointed out there were 12 respondents in the first exercise and 18 respondents in the second. We decided to draw a sample of one third of all information demand pattern. It is reasonable to consider the ratio of the respondents from both investigations. Therefore 4 IDP’s should be from the first exercise and 6

from the second one. We numbered the IDP's from the first investigation from 1 to 12 and the IDP's from the second from 1 to 18. To draw the random sample we used 2 respectively 3 hexagonal dices.

When evaluating the quality of the ten patterns, we decided to apply and extend criteria addressing the quality of the pattern content originating from document engineering [8]. We defined the criteria as follows; "content" refers in this context to the textual parts in the pattern description:

- Comprehensibility (co): The content is well-structured and formulated clearly. The reader is able to understand the content easily.
- Completeness (cm): The content includes all information to completely describe the subject under consideration.
- Consistency (cn): No contradictions within the content or with respect to other parts of the pattern description can be detected.
- Soundness (so): The given information fits to the subject addressed and is considered realistic.
- Clarity (cl): The content or the information demand pattern can be applied without modifications.

In order to evaluate the presented criteria we decided to use marks from 1 to 5 being common practice in German Universities. In this context the marks are used as follows:

- 1 (excellent quality): The IDP is applicable without restrictions.
- 2 (good quality): The IDP is applicable with minor restrictions.
- 3 (average quality): The IDP is applicable with restrictions and needs minor revision.
- 4 (limited quality): The IDP is applicable with major restrictions and needs much revision.
- 5 (unusable quality): The IDP is not applicable.

Every IDP was evaluated according to the above criteria differentiating five specific parts of an IDP: context and problem, tasks and responsibilities, information demand, effects, and the pattern in total. This leads to 25 marks per IDP, i.e. five criteria for each of the five parts. Furthermore, the IDPs were evaluated by two researchers independently from each other to increase reliability. After the individual evaluation the results were compared and discussed. There were three differences about the rating between the investigators. After a discussion the identified reasons were as follows: two misunderstanding about the content of the IDP and one difference in the expectation about the results. The investigators were able to clarify the differences which leads to a joint view presented in section 4.2.

4.2 Results

The results are presented in table 5 and table 6, respectively. Table 5 shows the results for the "pattern in total" and the part "context and problem". The results for the other parts had to be omitted due to space limitations in this work. The missing parts are tasks and responsibilities, information demand and effects. The ten evaluated

IDPs are named from A to J in order to save space and since the names of the IDPs are not important for the further analysis.

Table 5 Example results in excerpts

IDP	Pattern in total					Context and Problem		...
	co	cm	cn	so	cl	co	cm	
A	2	1	1	1	2	1	1	
B	3	5	5	2	5	3	3	
C	3	3	3	2	3	3	3	
D	3	2	3	1	2	2	2	
E	3	4	4	2	3	2	4	...
F	3	4	5	2	4	3	4	
G	1	1	1	1	2	1	1	
H	2	3	3	1	2	3	2	
I	3	3	4	2	4	3	4	
J	3	3	3	3	3	2	2	

Table 6 shows the overall results about all investigated parts of the IDPs. The arithmetic average is presented for each rated part of the IDPs.

Table 6 Overall results

IDP	Pattern in total	Context and Problem	Tasks and Responsibilities	Information Demand	Effects
A	1,4	1,0	1,6	1,0	1,6
B	4,0	3,0	2,0	3,8	3,8
C	2,8	3,0	2,4	1,6	2,8
D	2,2	2,8	2,0	2,0	2,0
E	3,2	3,0	3,0	3,2	2,6
F	3,6	3,4	3,0	3,6	3,8
G	1,2	1,0	1,0	1,0	1,6
H	2,2	2,4	2,8	1,6	1,2
I	3,2	3,4	4,0	1,4	1,4
J	3,0	2,6	5,0	2,4	2,4

4.3 Discussion

The results of investigation did not confirm the conjecture that the quality of the parts “information demand” and “effect” is worse than the quality of the other parts and the overall pattern quality. The evaluation results did not show any patterns of dependencies at all between information demand, effects, context & problem or tasks

& responsibilities. This means it cannot be concluded that a certain quality level of one pattern part causes a certain quality level for another pattern part.

But the results showed that consistency and soundness got the lowest quality marks of the five evaluation criteria and that the "tasks & responsibilities" part gets the worst quality rating among all the parts of an IDP.

Our conclusion from the above results is that we need to support the construction of IDP in general and the development of the part "task and responsibilities" much more. Regarding the overall IDP, consistency and soundness between the different parts need to be improved. This could be done by offering checklists and practices for interconnecting the different IDP parts. Regarding "tasks & responsibilities", more examples and a thorough introduction into the concept of a role and the implications towards responsibilities from organization theory could be suitable measures.

5 Summary and Future Work

This paper extended work on IDP by addressing the aspect of how to improve their "inner" quality, i.e. the completeness, accuracy and pertinence of the pattern content. For this purpose, an investigation was performed with two steps. The first step involved students in a university course who apply the IDP structure for developing IDP candidate descriptions. The second step evaluated the IDP developed by the students with respect to the quality of the different parts of the IDP structure.

The main conclusion from the first step is that the respondents seem to have understood concept and structure of information demand patterns and were able to apply it on their own. The students learned how to use the information demand pattern structure for capturing information demand descriptions. The pattern structure was judged suitable and complete by the clear majority of the students. The significance of these observations is relatively low due to the limited experience level of the students, but nevertheless contributes to the validation of the IDP concept.

The conclusion from the second step is that consistency and soundness got the lowest quality rating and that the part "tasks & responsibilities" needs improvement. Such improvements could be reached by checklists and practices for interconnecting the different IDP parts.

This motivates continuous work into at least three directions:

- A method development effort should be initiated in order to create a systematic and integrated IDP development method.
- A similar validation effort should be made outside the academic context, i.e. to transfer the concept of information demand patterns to an industrially oriented community and evaluate the results of modeling information demand in such a setting
- In order to validate the IDP concept, the quality of the actual demand descriptions developed with this concept also has to be evaluated in a more systematic way than what was done in the exercise described

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