



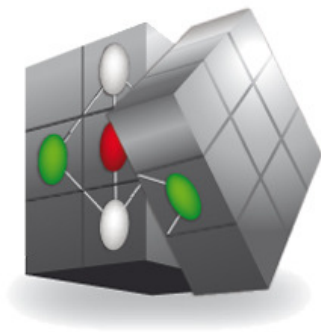
Combining and Uniting Business Intelligence with Semantic Technologies

Acronym: CUBIST

Project No: 257403

Small or Medium-scale Focused Research Project FP7-ICT-2009-5

Duration: 2010/10/01-2013/09/30



cubist

Your Business Intelligence

Evaluation of Final CUBIST Prototype

Abstract: This deliverable will provide the evaluation results of the final CUBIST prototype. (see use case prototypes D7.3.2, D8.3.2 and D9.3.2, and use case specific evaluations D7.4.1, D8.4.1 and D9.4.1)

Type	Report
Document ID:	CUBIST D1.4.2
Work package:	WP1
Leading partner:	SAP
Author(s):	Frithjof Dau (SAP), Karolin Stefani (SAP)
Dissemination level:	PU
Status:	Final
Date:	03. Nov. 2013
Version:	1.0



<Confidential>



Version	Description	Contributors
0.1	First draft	Frithjof Dau, Karolin Stefani (SAP)
0.2	Reworked	Frithjof Dau
0.3	Reworked – Integrated Interview Results	Karolin Stefani
0.4	Main results added	Frithjof Dau
0.5	Evaluation methods	Frithjof Dau, Karolin Stefani
0.6	Chapter 1 & 2 added	Frithjof Dau
0.7	Chapter 5 added	Frithjof Dau
0.8	First review comments addressed	Frithjof Dau
1.0	First review comments addressed	Frithjof Dau

Reviewers

Name	Affiliation
Simon Polovina	SHU
Casio Melo	ECP



1	OVERVIEW	4
2	HOW THE EVALUATION WAS CONDUCTED.....	6
2.1	EVALUATION SETTING.....	6
2.2	EVALUATION METHODS USED	6
3	METHODS FOR ANALYSIS OF THE EVALUATION RESULTS	10
3.1	FOR QUALITATIVE DATA ANALYSIS.....	10
3.2	FOR QUANTITATIVE DATA ANALYSIS	11
4	EVALUATION RESULTS.....	13
4.1	FINDINGS FOR THE OVERALL PROTOTYPE	14
4.2	FINDINGS FOR THE DIFFERENT COMPONENTS OF THE PROTOTYPE	20
5	SUMMARY AND PROPOSED FUTURE IMPROVEMENTS.....	33
6	APPENDIX	35



1 Overview

This deliverable contains the use-case independent evaluation of the CUBIST prototype. It belongs to a series of deliverables and documents, which we describe first:

- 1) The starting point of the evaluation is the deliverable D1.4.1 “Directives for the Evaluation of the Use Case Prototypes“. This deliverable provided guidelines and directives for the evaluations of the use case prototypes. Essentially, this deliverables provides the rationales for choosing the following methods during the evaluation:
 - a. A walk-through for use-case-specific tasks using the prototype by the test users, utilizing the think-aloud-method
 - b. Structured interviews conducted with the test users
 - c. Questionnaires filled by the test users
- 2) Moreover, the actual procedure on how the evaluation had to be conducted is described in this deliverable.
- 3) In addition to D1.4.1, a separate document “Appendix to Directives for the Evaluation of the Use Case Prototypes” has been provided. This document contains
 - a. the actual structured interviews and questionnaires, i.e. the questions of the interviews and questionnaires, and
 - b. additional information material for the test users, describing
 - i. some background of the overall evaluation,
 - ii. the envisioned conduct of the evaluation
 - iii. tasks users have to carry out before they entered the evaluation
 - iv. explanation of the tasks the users have to carry out during the evaluation, and
 - v. some information about the “conceptual scaling” feature in CUBIST.

The interviews, the questionnaires, and the additional information material have been provided to the use case partners as separate documents.

- 4) Moreover, a comprehensive tutorial video (>30 min) has been created and provided to the test users some weeks before the evaluation was conducted.
- 5) Based on the material described above, the evaluation has been conducted. For each use case, the results (most importantly, the answers in the interviews and questionnaires) are provided in the deliverables D7.4.1, D8.4.1 and D9.4.1 “Evaluation of Use Case Prototype”.
- 6) This deliverable takes the results as given in D7.4.1, D8.4.1 and D9.4.1, evaluates them and draws use-case independent conclusions.

An overview over the document flow is given in Fig 1.

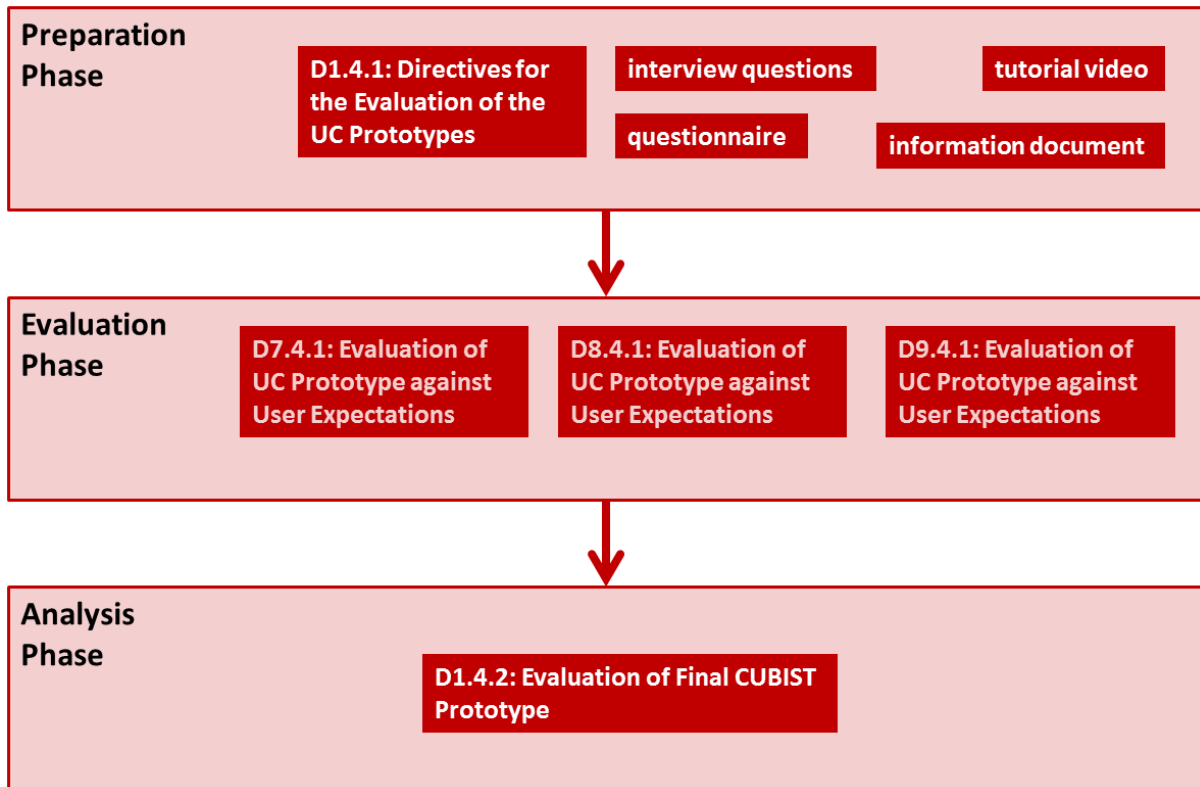


Fig 1: Documents of the CUBIST evaluation

In the next chapter, we provide an overview on how the evaluation was conducted. The results of the evaluation phase, i.e. the interview and questionnaire answers of the users, are the basis data of this document. In chapter 3, we describe how this data was evaluated. The results of this data evaluation, including first conclusions, are given in chapter 4. Finally, in chapter 5, a summary and overall conclusion is provided.



2 How the Evaluation Was Conducted

2.1 Evaluation Setting

Overall six¹ evaluation runs have been conducted with two users per use case.

The test users take different professional roles and show a varying level of computer skills:

User (Use Case)	Profession	Computer Skill (self-assessed)
Saliha Klai (SAS)	SOLAR Operator	Good
Carla Jacobs (SAS)	Operations Engineer	Good
Peter Stevenson (HWU)	Software Developer	Very Good
Chris Armit (HWU)	Senior Editor of EMAGE	Good
Nathan Milsom (INN)	Project Manager	Very Good
Danielle Thomas (INN)	Support Coordinator	-

The evaluation was conducted virtually with the help of SAPConnect, an online CSCW tool.

Prior to the evaluation the users were able to study tutorial material explaining the systems features and functionalities.

During evaluation, the users had access to their respective use case prototype via Internet and were asked to solve two to three specific tasks they had chosen prior to the evaluation run.

After working with the system, the test users were asked some questions in the form an interview. Finally, they were presented a questionnaire which they could fill in and send back after the evaluation had taken place.

2.2 Evaluation Methods Used

2.2.1 User Testing/Thinking Aloud

The first part of each user evaluation used the think-aloud method. For each of the three use cases, tasks were defined by the partners beforehand and was carried out in the think-aloud-sessions. According to D1.4.1, the users were asked to perform the tasks they have provided in the preparation phase and find the information they already knew using CUBIST and their data. The evaluators encouraged the test users to think aloud. Apart from the recording, the evaluators will take notes during this phase.

¹ This number seems small, but is a reasonable size for an evaluation, as “Why You Only Need to Test with 5 Users” by Jakob Nielsen (<http://www.nngroup.com/articles/why-you-only-need-to-test-with-5-users/>) shows.



Note first that we have three sets of tasks, each set carried out by two users. Moreover, we have significant differences between the users with respect to the experience they already had with the prototype: Some users have been complete novices, using the prototype for the first time during the evaluation, whereas other users had already strong experience with CUBIST. This renders the results of the session difficult to compare.

In D1.4.1 it was envisioned that the user's walk on their own through the tasks, with minimal help (if any) by the interviewers. A test run which was conducted before the actual evaluation was done revealed that this envisioned approach fails with novice users. Thus depending on the use case and the experience of the users, the method has not been followed to the book, but altered in order to gain the best results for the interviews and questionnaires. For example, for novice users in the HWU use case, an HWU expert went instead of the users through the tasks and explained the prototype.

The thinking aloud method was used to understand the user's train of thought, and aimed at providing the minimum amount of support such that the user has a sufficient impression, based on walking through the tasks, of the prototype in order to conduct the interview and the questionnaire. Also:

- 1) As it seems unfeasible to compare direct results from the think aloud sessions, and
- 2) As the think aloud method has been altered during the evaluation,

we do not further evaluate these sessions in this deliverable.

the prototype in order to conduct the interview and the questionnaire.

Also,

- 3) As it seems unfeasible to compare direct results from the think aloud sessions, and
- 4) As the think aloud method has been altered during the evaluation,

we do not further evaluate these sessions in this deliverable.

2.2.2 Interview

One part of the evaluation was an interview conducted after the test users had tried to fulfil their tasks with the system.

The interview was structured from general questions about the tasks and the system's usability to specific questions about the different system components. Thus, not only general impressions about the system could be evaluated but also especially well-designed features as well as specific drawbacks could be examined.

In the beginning of the interview the user had to state some personal facts about themselves regarding professional role, computer skills, computer usage etc. Afterwards, they had to describe the two tasks they conducted with the prototype during evaluation. Then the actual interview about their experience started with several questions.

The questions were a mixture of open-ended and closed-ended questions. When there were closed, ended questions the users had the possibility to add some additional textual comments and explanations.

Some of the questions regarding additional tasks that might be fulfilled with CUBIST and the users' experiences when working with "traditional" analytical systems were marked as optionally due to time restrictions for the evaluation execution which had been identified in trial-runs beforehand.

Due to the questions characteristics the interview mainly resulted in qualitative data that has been incorporated in this evaluation document.

For details on how the qualitative interview data was analysed see section 3.1.



2.2.3 Questionnaires

Finally, questionnaires have been used during the evaluation in order to gather quantifiable, measurable information.

2.2.3.1 The Questions

Similar to the interview, it is structured based on the different components in CUBIX, and they aim at measuring, from a user's perspective, the effectiveness, efficiency, and satisfaction when dealing with the prototype. Thus, the questionnaire is essentially divided into two parts:

- 1) The first part evaluates the overall prototype.
- 2) In the second part, each component of the prototype is evaluated separately.

The questions for the overall prototype are unique for this section. Moreover, in this section general questions about how well the different components in CUBIST are interacting are placed. In total, we have the following questions:

- The CUBIST software was easy to use and work with.
- Neglecting the currently prototypic character, I would like to use the CUBIST software in future again.
- In future, I would prefer CUBIST to other analytical tools I currently use.
- Using CUBIST software could make my work more effective and efficient.
- The integration of different components (used to access, explore and visualize information) was helpful for fulfilling my tasks.
- The different components and the visualizations in CUBIST are well integrated.
- It is clear how the different components interact.
- The navigation/interaction functionalities were easy to understand and apply.
- It was easy to follow the steps performed by the system when using the interaction functionalities.
- Describe idea and how it was used in the evaluation process; Describe categorization of questions and why a certain range of possible answers was used

Next, for each of the components "Search and Select", "Navigate in Data", "Explore Selection" and "Analyse Selection", the following identical questions are posed:

- The purpose and function of the component is clear.
- The component is easy to understand and use.
- The interface is appealing and attractive.
- The component is useful.
- For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.
- I have similar functionalities in the tools I usually use.

Using the same set of questions allows an easy comparison of the different components from different perspectives.



Finally, the Visual Analytics in CUBIST, which belong to the “Analyse Selection”-component, have been a core target of the research conducted in CUBIST. For this reason, additional questions for the “Analyse Selection”-component have been posed, namely

- The visualizations were easy to understand.
- There are visualizations available that did fit my tasks very well.
- The integration of different visualizations was helpful for fulfilling my task.
- It is clear how the different visualization interact.

2.2.3.2 The Scales

For harvesting quantitative results in the evaluation, questionnaires with Likert-Scales are used. An example for CUBIST is provided in Fig 2.

The purpose and function of the component is clear.	strongly agree	neutral	strongly disagree	n/a
	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
The component is easy to understand and use.	strongly agree	neutral	strongly disagree	n/a
	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
The interface is appealing and attractive.	strongly agree	neutral	strongly disagree	n/a
	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
The component is useful.	strongly agree	neutral	strongly disagree	n/a
	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
For some kinds of information needs or queries, particularly this component (or similar components based on the same approach) is useful.	strongly agree	neutral	strongly disagree	n/a
	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>
I have similar functionalities in the tools I usually use.	strongly agree	neutral	strongly disagree	n/a
	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/>

Fig 2: Example for Likert-Scales used in CUBIST

In these examples, we have six *questions*, to which a user can provide *answers* or *ratings*. As answers we always provide 6 choices from “strongly agree” to “strongly disagree”. In addition to this, a user can decide “not to answer” and choose “n/a”. In the analysis, we often only count the “real answers”, e.g. any answer excluding “n/a”. Note we use an even number of real answers, thus the user cannot stay neutral, but is forced to show a tendency.

Finally note that all questions are testing “positive” attributes (e.g. clearness or usability), except the last one. The last question evaluates the novelty of the feature. The more a user disagrees to the question, the more novel the component is.



3 Methods for Analysis of the Evaluation Results

As described in D.1.4.1 “Directives for the Evaluation of the Use Case Prototypes”, we used structured interviews to gather non-measurable information in the evaluation. That is, all questions have been defined beforehand, including a predetermined order, and sometimes even specific answer categories are provided. Here qualitative information was collected. To gather quantitative information, each test user had additionally to fill a questionnaire. The actual interview questions and questionnaire have been provided in the “Appendix to D.1.4.1 “Directives for the Evaluation of the Use Case Prototypes”. In the next two sections, we describe how the two forms of gathered information –qualitative and quantitative–have been evaluated.

3.1 For Qualitative Data Analysis

The interview questions mainly focused on qualitative data about the CUBIST prototype.

For analysing and comparing the answers given, the interview questions have been categorised into ten broader groups:

- 1.) Questions aiming at the ability of task fulfilment/analysis requirement fulfilment
- 2.) Questions aiming at the prototype’s usability
- 3.) Questions aiming at the „Search and Select“ – Panel
- 4.) Questions aiming at the „Navigate in Data“-Panel
- 5.) Questions aiming at the „Explore Selection“-Panel
- 6.) Questions aiming at the „Scale Selection“-Panel
- 7.) Questions aiming at the „Analyse Selection“-Panel
- 8.) Questions aiming at the traditional visualization (e.g. bar charts)
- 9.) Questions aiming at the other functions
- 10.) Questions aiming at identifying missing features/useless features/drawbacks

Group 1, 2 and 10 cover general aspects about the prototype. The remaining categories focus on single components.

The assignment of the single interview questions to the different groups is shown in the Excel “CUBIST_Interview_Results.xlsx” which is part of the appendix of this document. A list of all answers to all questions for all test users can be found in that Excel as well. The numbering for the single interview questions and their parts used in the Excel has been integrated in this evaluation document to make tracking the origin of the results easier. The numbering is added in brackets where necessary.

The answers given were compared per question and category over all test users. If possible, most striking similarities and differences among the answers given have been stated in the following sections of this document.

As many answers required natural language processing, which was done manually for this evaluation, similarity detection has mainly been based on synonym identification.

Additionally, questions that have been skipped or answered as “not relevant” are examined for patterns.



As the test users take different roles and show different computing skills the answers were checked for correlations with the users' roles/skills.

3.2 For Quantitative Data Analysis

3.2.1 The Scales

In order to make the real answers measurable, we assign the following numbers to them:

strongly agree					strongly disagree
1	2/3	1/3	-1/3	-2/3	-1

That is, we consider a normalized Likert-Scale. As the numbers of users is rather small, the only statistical means we use for set of users is

- 1) The number of the users (i.e., the size of the set), and
- 2) The average of the user's answers.

For the user's answers, bar-charts depicting them will give a sufficient basis in order to evaluate them further. The diagrams are explained in the next section.

3.2.2 Diagrams

In the analysis, we use two different kinds of diagrams, namely an overview diagram and a more detailed diagram. Moreover, we always show diagrams for two sets of users: Users from all three use cases, i.e. users from HWU/SAS/INN, and users who are not Innovantage users, i.e. users from HWU/SAS. The rationale for this is provided at the beginning of the next chapter.

The first kind of diagram gives for a set of associated Likert-Scales an overview over the real answers. That is, in the diagrams, only the "real answers" are provided (there is no bar for "n/a"). For each question, the height of the left diagram is scaled to 6 (as we have HWU/SAS/INN-users). Similarly, the height of the right diagram is scaled to 4. The next number shows the number of real answers given. Finally, the cell with the bar and number on the right of the diagram shows the average rating, where the rating-numbers follow Fig 5 and where the number of real answers is taken into account.

For the "Explore Selection" Component	With Innovantage			Without Innovantage		
The purpose and function of the component is clear.		4	0,50		2	0,57
The component is easy to understand and use.		4	0,50		2	0,57
The interface is appealing and attractive.		4	0,17		2	0,57
The component is useful.		4	0,57		2	0,57
For some kinds of information needs or queries, particularly this component is useful.		4	0,57		2	0,57
I have similar functionalities in the tools I usually use.		3	-0,56		1	-1,00

Fig 3: Example Rating Overview

In addition to the overview, the next kind of diagram combines the answers for all questions, including "n/a"-answers, in in diagram. This diagram should be self-explanatory.

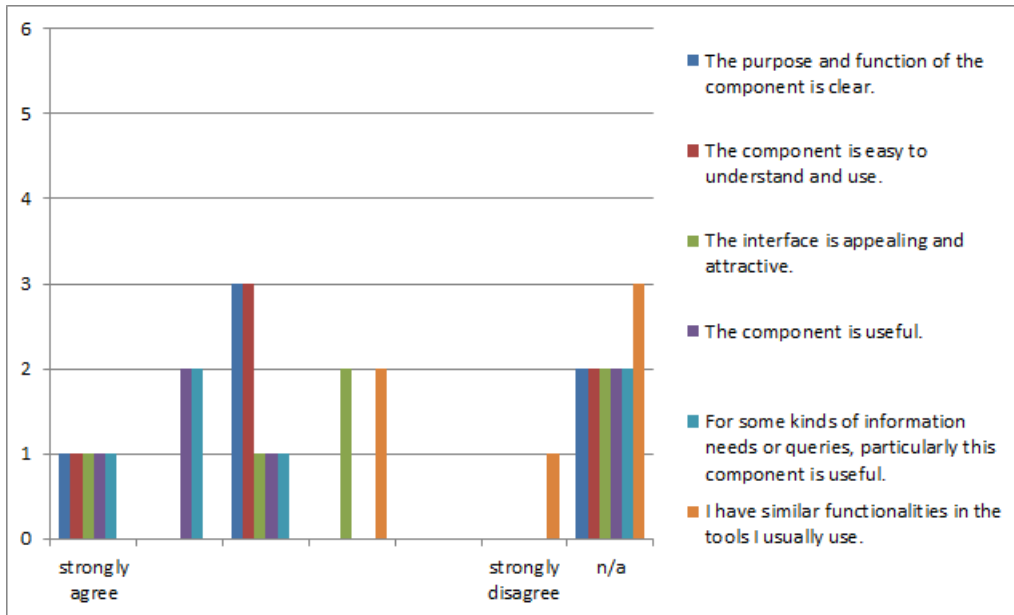


Fig 4: Example for a “Result Diagram”



<Confidential>



4 Evaluation Results

For the analysis of the questionnaire results, we always consider two sets of users: First, the set of all users, and second, the set of all users from HWU and SAS only, excluding the INN users. There are two reasons for doing so:

- 1) First of all, from the beginning of CUBIST there has been an important distinction between HWU and SAS on the one side and INN on the other side: Both HWU and SAS deal with special data, not with standard business data, and both HWU and SAS have specific information needs, e.g. finding specific clusters and dependencies between data attributes. INN, on the other hand, has clearly a business related data sets, and their information needs fall into the area of needs addressed by traditional BI-tools. We are amongst other things interested to investigate the difference between traditional BI means and novel BI means like graph-based visualizations, and whether CUBIST satisfies “non traditional” BI information needs. For scrutinizing such questions, splitting up the test users as described is certainly helpful. For example, the comparison of charts for HWU/SAS and HWU/SAS/INN can be used to check how CUBIST performs where it is unlikely or impossible to benefit from traditional BI means.
- 2) Second, for the evaluation it is important to note that, shortly before the evaluation was conducted, the former project partner INN has been acquired by another company. The new company took over the respective participation in CUBIST, but due to the change, this was carried out by new project members who had only little time to get acquainted to CUBIST. We realize that this renders the results from the INN users less reliable and robust, but they are still usable in the evaluation.



4.1 Findings for the Overall Prototype

4.1.1 Findings Regarding the Support to Fulfil Certain Tasks and Analysis Requirements

In this section the results regarding the system's ability to support the user in fulfilling their analytical tasks and requirements are stated. Detailed descriptions about the single tasks conducted can be found in the use case specific evaluations D7.4.1, D8.4.1 and D9.4.1.

The sub-paragraphs correspond the interview structure. In the sub-paragraphs, we refer additionally to appropriate questions and results of the questionnaires. Each question of the questionnaire is covered at least once.

General Assessment of the CUBIST prototype (Questionnaire)

With an average rating of 0.17 for HWU/SAS/INN and 0.25 for HWU/SAS, the answers to “The CUBIST software was easy to use and work with” show that the usability of the overall prototype is slightly positively rated. It should be noted that, as the discussions of the separate CUBIST components in the next section show, the usability *per component* significantly differ.

The next three questions in the questionnaire aim at assessing the usefulness of CUBIST. Here we have significant differences between HWU/SAS and INN. First of all, the question “Neglecting the prototypic character, I would like to use CUBIST in future again” is rated 0.33 for HWU/SAS/INN and 0.89 for HWU/SAS. That is, the users of the use cases where non-traditional BI-means are needed rate the usefulness of CUBIST in a strongly positive manner. The users from INN, though, rate the usefulness negative, which causes the drop in the overall rating. Next, the question “Using CUBIST software could make my work more effective and efficient” is rated 0.67 for HWU/SAS, that is, the users of HWU/SAS see a clear benefit in using CUBIST. Again, INN is different here: The INN-users provide negative answers to this question, which causes the overall rating for HWU/SAS/INN drop to 0.2. Even though that (for HWU/SAS) the usefulness of CUBIST is quite positively assessed, CUBIST does not supersede existing tools: For the question “In future, I would prefer CUBIST to other analytical tools I currently use” we have with an average rating of 0.33 for HWU/SAS, thus even in these use case the users show only a weak preference for CUBIST. The INN users provide negative answers to the questions, so that the average for HWU/SASS/INN drops to -0.08. This results supports the CUBIST-approach to complement, not replace, existing BI-tools. #

Finally we consider the question “The integration of different components was helpful for fulfilling my tasks”. This question has only been answered by HWU/SAS-users. All of them give a positive rating to this question, leading to a quite high average rating of 0.67. This answer supports the hypothesis that different tasks need different means to explore and analyse the information space, which is addressed by the CUBIST approach to integrate in one tool such different means.

Using the detailed answers of the interviews, the next sub-sections go into more details on how CUBIST supports to fulfill different user tasks.

Expectations Regarding Task Fulfilment with CUBIST: (Interview 1.2)

Three of six users emphasized that they expected the system to easily retrieve data and let them easily perform searches on the data. They wanted the system to support them in seemingly performing their tasks. They did not



further detail what they exactly expected for which subpart of their tasks nor did they relate to their specific tasks at all.

Only one user described in detail what he expected in connection to his task. Two users did not state their expectations at all.

Overall Value of Information and Functionality Offered by CUBIST: (Interview 2.1/2.2)

The data search functionality in general, the time-range and faceted search selections were evaluated as very useful functionalities. In the HWU use case evaluation the Hasse-Diagram was stressed to be especially useful to visualize the kind of underlying data sets. Though, the user also mentioned that it takes a while to understand that kind of graphical representation.

One user described that the kind information that can be retrieved with the system is very useful e.g. the relations and clusters in the data that can be analysed. However, another user, with rather technical background, stressed that expert domain knowledge is required to understand the system and its visualization correctly.

Two users mentioned that visualizing and understanding the data is difficult when lots of data points are selected and numerous attributes displayed.

It is claimed that only selected functionalities are useful for selected use cases. Thus, not all functionalities offered by the system seem to be generally applicable.

Ability of CUBIST to Discover New Unknown Facts within the Data Sets: (Interview 3)

The ability of discovering new unknown facts in the underlying data sets with CUBIST seems to depend on the specific use case, the data set size and on how well the underlying data is already known by the users.

Both SAS use case testers discovered new facts. They either discovered facts that proved to be different than expected before or they analysed new parts of the overall data set they did not look at with their legacy systems before.

In contrast, one of the HWU use case testers only discovered what he expected to discover from the data sets emphasizing that CUBIST offers another way looking at the data to him. The other HWU tester could not test the system in the required level of detail to answer this question due to personal time constraints.

No answers were given by the INNOVANTAGE use case testers.

This implies that the bigger a data set is and the less known the details in the data are the more CUBIST serves discovering new facts in a data set.

Ability of CUBIST to Enrich Daily Work by Offering New Ways of Data Analysis: (Interview 4/20)

Five out of six test users affirm that CUBIST offers new ways of data analysis. Numerous times it was claimed that CUBIST is especially useful for large data sets.

However, it was also mentioned that further adjustments to the special use cases might be necessary.

Only one user, who took a pure software development point of view, mentioned that the system does not enrich his daily work as a software developer.

The test users claimed the ability to parameterize the searches, grab portions of the data sets and especially visualizing graph-based data with its clusters and relations were real enrichments offered by CUBIST. The



possibilities to dynamically filter large data sets and immediately viewing the filtered results in the visualizations were also explicitly mentioned.

CUBIST's Performance Compared to Other Analytical System Currently in Place: (Interview 5/6.1/6.2)

Only one of SAS's test users has answered the questions related to this part, as the HWU use case users have stated that there are currently no other analytical systems in place.

For the SAS use case it was mentioned that the tasks and analysis requirements are so much individual per user that current systems cannot be generically reused. Thus, they currently do not use "real" analytical systems but lots of little individual scripts on a case by case basis. The CUBIST prototype offers them a way to analyse what they really want to analyse and even to mechanise the analysis of data that is currently analysed manually.

Task Suitable or Not Suitable for CUBIST from User's Point of View: (Interview 8/9)

The interview questions regarding which tasks CUBIST would fit well or not have not been answered due to time restrictions.

4.1.2 Findings Regarding the Usability of the Prototype

Different question were asked regarding the usability of the prototype.

General Assessment of the CUBIST prototype's Usability (Questionnaire)

CUBIST consists of several components (like the "Search and Select" panel, the "Explore Selection" panel, and the "Analyse Selection" panel) which interact. The last four questions for the overall prototype of the questionnaire evaluate how well from the user point of view those components are integrated and interlinked.

The first question "The different components and the visualizations in CUBIST are well integrated" is by all users positively answered, and there is only a minor difference between the average rating for HWU/SAS (0.5) and HWU/SAS/INN (0.44). But not all users do understand on how the components interact: three (including both INN users) out of six users rated the question "It is clear how the different components interact" negatively. So particularly the novice INN-users have difficulties in understanding how different components are linked. This insight is seconded by the question "It was easy to follow the system's steps when using the interaction functionalities": again, the INN-users rate this question negatively. Without INN, we have average ratings 0.5 and 0.67 for the two questions, whereas the negative answers of the INN-users let those ratings drop for HWU/SAS/INN to 0.22 respectively 0.13. Finally, with average ratings of 0.58 for HWU/SAS and still 0.44 for HWU/SAS/INN, the question "The navigation/interaction functionalities were easy to understand and apply" is positively answered. So even though conceptually, it is not always clear how components interact, the overall navigation between components and the interaction with components is positively rated.

CUBIST provides a large number of different Visual Analytics means in the "Analyse Selection" panel. The user has to understand on how those means interact, and which means is best suited for his particular information need. This is evaluated with some questions in the interview and discussed in the next subsections.

Ease of Selecting the Most Appropriate Analysis and Visualization Techniques: (12)

The users' impression of selecting the most appropriate analysis and visualization techniques offered by the system ranges from easy to difficult.



Repeatedly it is mentioned, that it is difficult to understand the system’s functionalities when working with it for the first time. With growing experience the visualizations and analysis opportunities are better understood and thus it becomes easier to select the most appropriate techniques.

One user from the HWU use case claims that the only visualization making sense in his use case is the Hasse-diagram. This either implies that he was immediately able to select the visualization appropriately or that he did not consider the other visualizations to be useful as well at all.

Ease of Reading the Visualizations: (16/2.2)

All users claim that they did not immediately understand how to read the visualizations and how to use the functionalities. This goes along with the results from the previous paragraph.

Only after some initial tutorials and prior training the users felt able to read the visualizations appropriately.

Issues mentioned that could improve understandability when they are solved include labeling, instructions for each visualization on each page, and an introduction to Formal Concept Analysis.

For reading the visualizations in general it is also mentioned that the visualizations are difficult to read when lots of data points and attributes are selected at once.

Ease of Understanding How the Analysis/Visualization Means interact: (14)

All users think that they understood how the different analytical means interact.

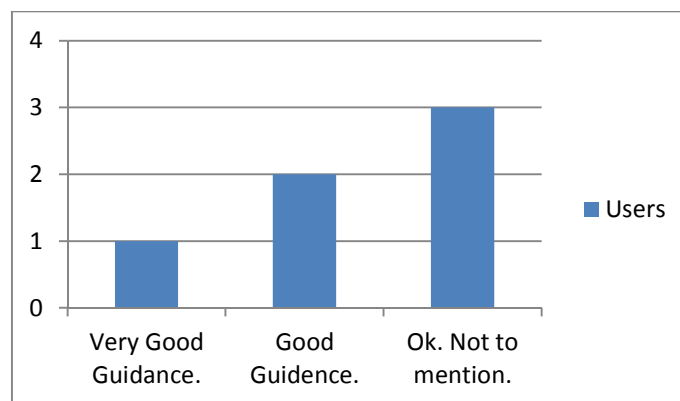
However, two of them also mentioned that it is absolutely necessary to know the underlying datasets and its structure very well. It is also necessary to think about the tasks beforehand to navigate efficiently through the visualization and interpret them correctly.

One of the users explicitly claimed that CUBIST is a kind of expert tool.

Guidance Offered by the System: (15)

The guidance offered by the system was not perceived to be a very special element.

The users find the search functionality straight-forward and the overall handling of the system quite logical. However, it is also mentioned that some visualizations are not self-explaining and that the help functionality is still poor.





4.1.3 Summary and Conclusion

Summary: CUBIST provides new ways of data analysis. The users appreciate generally the integration of different components, and the evaluation shows that due to the diversity of different tasks, different components and visualizations are needed. The search and filter functionalities in CUBIST are considered very useful. The same holds for the novel Visual Analytics. For them, the Hasse-diagrams are particularly appraised, but it is also said that the diagrams are not easy to understand and require some learning, and that CUBIST needs expert domain knowledge is required to deal with the prototype. CUBIST is strong when it comes to finding clusters and relations in the data, but the comparison between HWU/SAS and INN shows that it is not well suited when it comes to fulfilling more traditional BI-related information needs. In fact, the new means provided by CUBIST help users to discover unexpected facts, and the bigger a dataset is, the more CUBIST is helpful in this respect. Both the interviews and the questionnaires show that the integration of different components is helpful, as only selected functionalities are useful for selected (use case dependent) tasks. In total, the CUBIST approach is helpful when experts for a given domain need to explore and analyse relation and clusters in data. The evaluation shows furthermore that in CUBIST, from a usability point of view, integrating different components and visualizations is challenging

Conclusion: The use cases show the downsides of traditional BI-tools, when it comes to non-traditional use cases, where experts for a given domain have non-traditional information needs (like finding relations or clusters in the data). CUBIST shows that future expert BI-tools which aim at supporting a broader range of information needs can be extended: Novel, graph-based visualizations pay off when they are integrated into existing tools, and when the users take their time to learn and understand them. That is, future BI tools have to comprise quite different Visual Analytics means, ranging from traditional to novel ones, and one should not hesitate to include unfamiliar, sophisticated visualizations into expert BI tools, even if those visualizations are not ease to digest from the very beginning. Care has to be taken on how in such future tools different components and visualizations are integrated and how they interact, and further research on how one can integrate different information access means in one tool in a user-friendly, understandable way.

4.1.4 Charts

For the overall prototype	With Innovantage		Without Innovantage	
The CUBIST software was easy to use and work with.	6	0,17	4	0,25
Neglecting the prototypic character, I would like to use CUBIST in future again.	5	0,33	3	0,89
In future, I would prefer CUBIST to other analytical tools I currently use.	4	-0,08	2	0,33
Using CUBIST software could make my work more effective and efficient.	5	0,20	3	0,67
The integration of different components was helpful for fulfilling my tasks.	6	0,67	4	0,67
The different components and the visualizations in CUBIST are well integrated.	6	0,44	4	0,50
It is clear how the different components interact.	6	0,22	4	0,50
The navigation/interaction functionalities were easy to understand and apply.	6	0,44	4	0,58
It was easy to follow the system's steps when using the interaction functionalities.	5	0,13	3	0,67

Fig 5: Ratings for the Overall Prototype

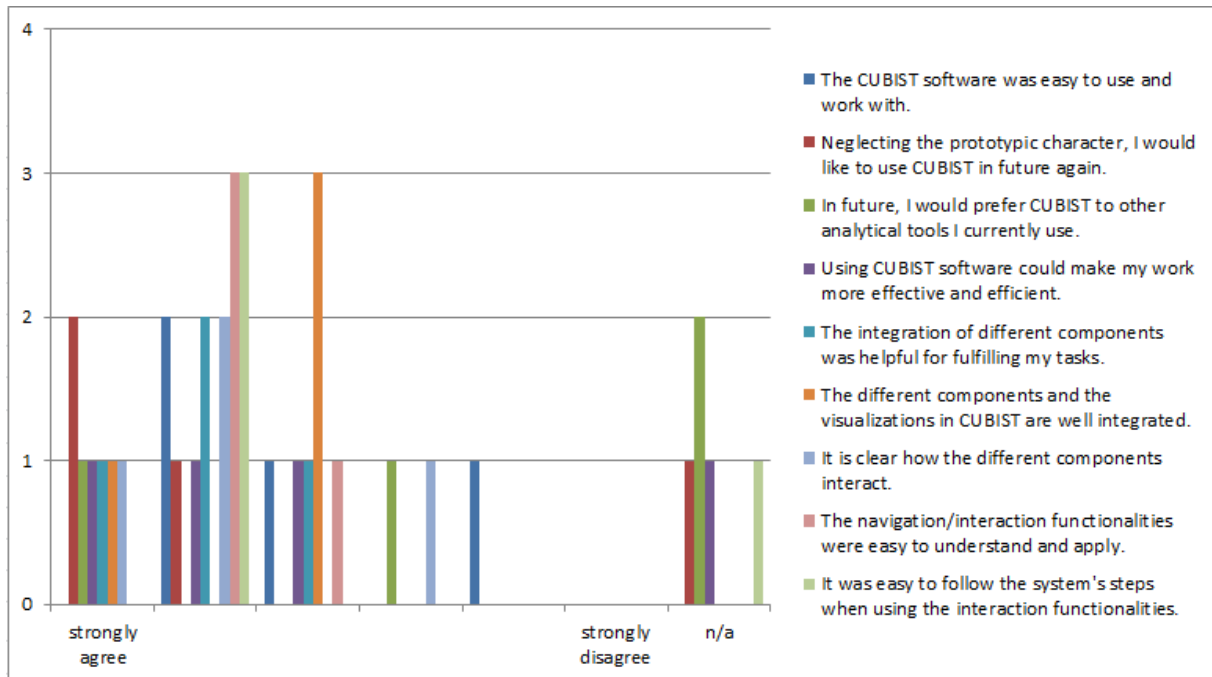
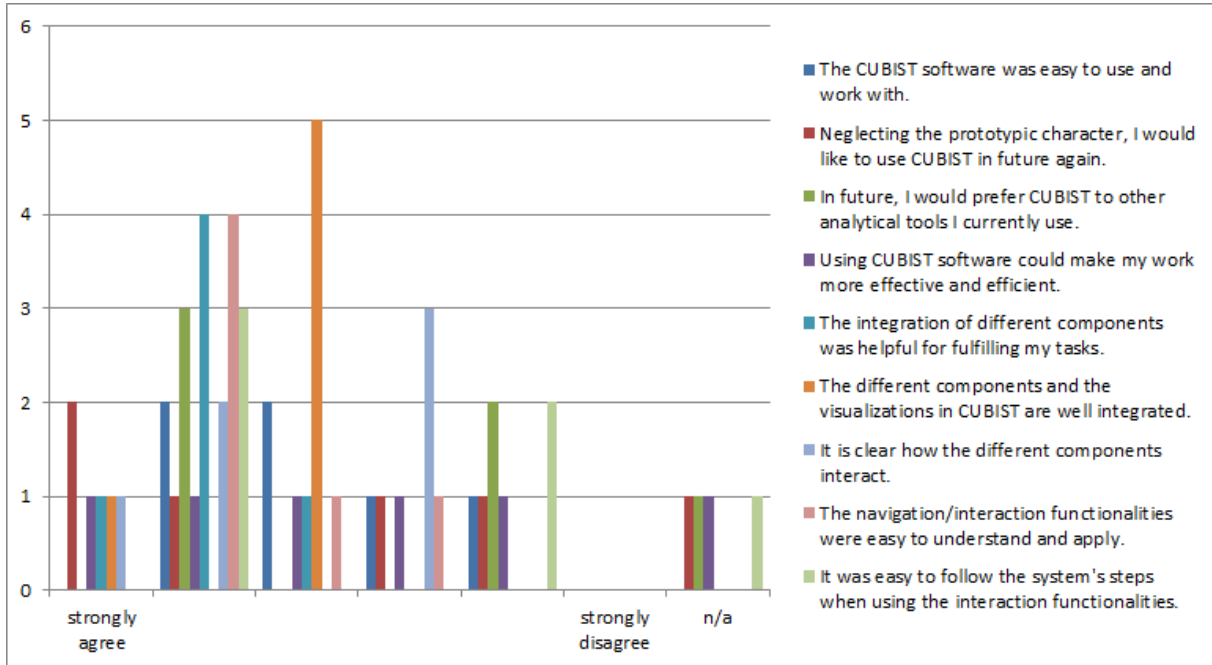


Fig 6: Results for the Overall Prototype, with Innovantage (above) and without (below)



4.2 Findings for the Different Components of the Prototype

4.2.1 Comparison of the different Components

A first glance shows all components are in general positively rated. The “Search and Select” and “Explore Selection” panels are in total, albeit not in all aspects, better rated than “Navigate in Data” and “Analyse Selection” panels. They have a clearer purpose and are considered more useful, both for HWU/SAS and HWU/SAS/INN. For HWU/SAS, they are moreover easier to use, whereas for INN, the ease of use drops down for “Search & Select”. This component is moreover rated unappealing and unattractive by INN, and is not considered to be significantly novel (slightly novel for HWU/SAS, not novel for INN). Note that “Graph-Exploration” is considered more novel than “Analyse Selection”, and note that we have a significant difference comparing HWU/SAS and HWU/SAS/INN. Both HWU and SAS consider this component extremely novel., whereas INN does consider this component familiar (but still, we have for HWU/SAS/INN a minor better rating for “Explore Selection” compared to “Analyse Selection”).

The purpose of “Navigate in Data” is to some degree clear to the partners, and its ease of use is passably positively rated. The usefulness it rated positive, but quite low (in fact, worst amongst all four components). Moreover, it is by all partners considered far the least innovative components.

“Analyse Selection” finally has diverse rating. Its purpose is less clear and it is considered slightly less useful (for HWU/SAS) than “Search and Select” and “Explore Selection”. This component clearly suffers from its complex functionalities: By all partners, it is not considered easy to be used (this is the only negative rating for all questions and components, when we consider the answers from HWU/SAS), and amongst all components, it has the lowest rating with respect to its appeal and attractiveness. Finally, as already been mentioned, this component is not rated the most novel component in CUBIST. As the Visual Analytics in CUBIST are essentially based on Formal Concept Analysis, which was unknown to all partners before the project started, this is a very surprising fact. Particularly for INN, their rating would require further investigation.

Note that for all components, particularly for the questions “is appealing and attractive” and “is easy to understand and use), we have significant differences between HWU/SAS and HWU/SAS/INN. In fact, as it can be seen from the single evaluations, the two INN-test users did particularly not like the appearance of CUBIST.

Summary and first conclusions per component:

- 1) **“Search and Select”** is considered most useful, with a positive tendency to being easily used and being appealing. But it is not considered very novel.

Conclusion: Faceted Search Frontends should be used in BI-solutions, but they are not a distinguishing feature.

- 2) **“Explore Selection”**: This component is considered very useful as well, its purpose is essentially clear to the users, and it is considered (apart from Innovantge) being appealing and attractive. This component is seen as most novel (even by INN), with the highest rating by all users from HWU/SAS.

Conclusion: Future BI-tools should be augmented by graph-exploration means.

- 3) **“Navigate in Data”** is slightly useful, the purpose is not too clear to the users, and it is considered not novel as all.

Conclusion: For future tools, this component could be left out.

- 4) **“Analyse Selection”**: The Visual Analytics in CUBIST are considered useful particularly in the “non-traditional-BI-use cases” HWU/SAS. As the interviews second, the novel CUBIST lead to insights not



possible with traditional tools. BI. It is considered relatively novel. But the ease of use, and the appeal and attractiveness of this component are badly rated.

Conclusion: The questionnaire provides evidence for the claim that the Visual Analytics of CUBIST do indeed complement traditional BI, but further research is needed to render them more easy to use, and it has to be investigated how it can be better presented to the user.

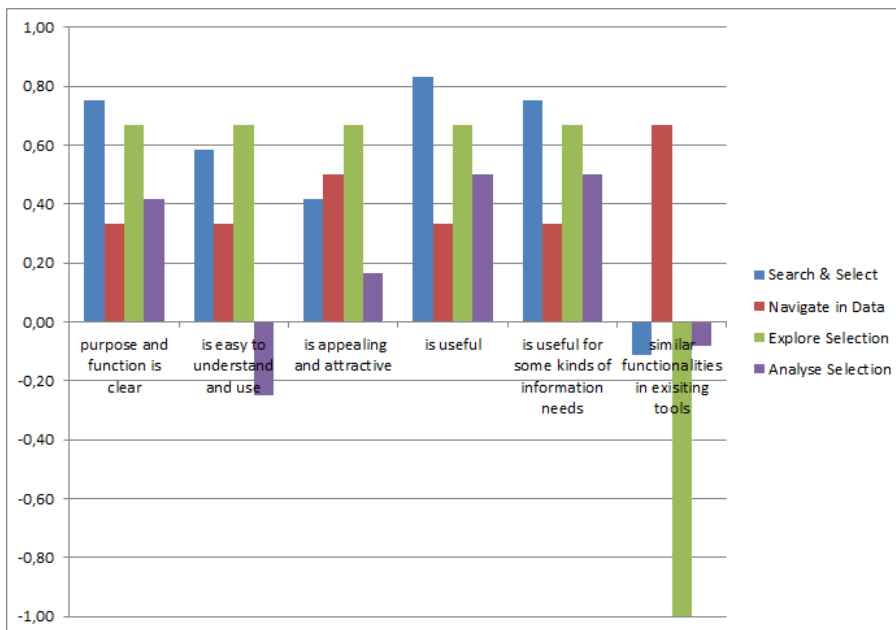
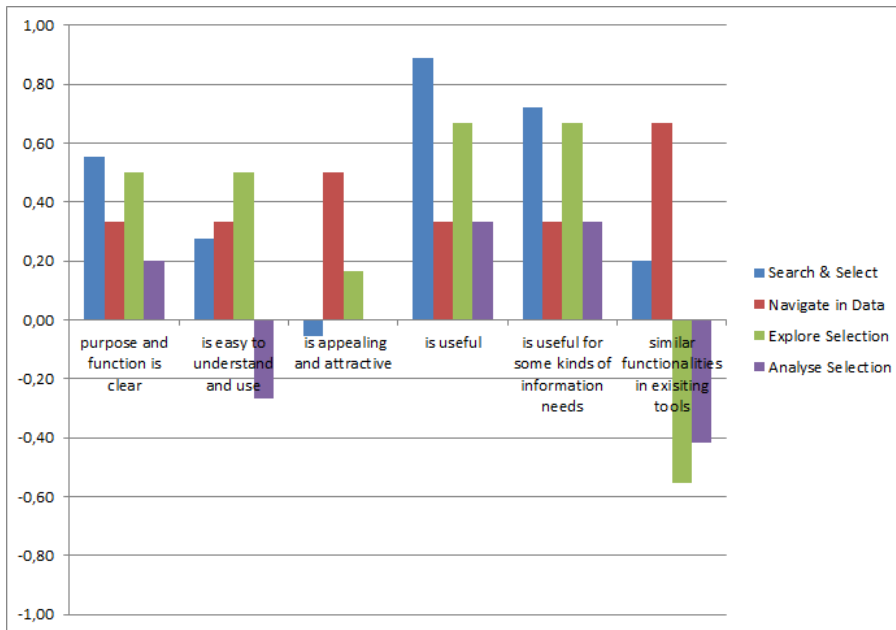


Fig 7: Comparing the different components, with Innovantage (above) and without (below)



Findings for the “Search and Select” Component

The “Search and Select” panel is from a user’s perspective the entry-point of the prototype and the starting panel from which other panels (like the “Explore Selection” panel or the “Analyse Selection” panel) are reached. Thus, unsurprisingly, this component is evaluated by all test users, and we have only one “n/a” in only one questionnaire.

The “Search and Select” panel is one of the best rated components of the prototype. This component gained remarkably positive ratings for the questions “the component is useful” and “the component is useful for some information needs”. Moreover, the purpose of this component is very clear to the users: There is only one slightly negative rating, and we have an average rating of 0.75 for HWU/SAS and still 0.56 for HWU/SAS/INN. This insight is nicely stated by a test user as follows:

The “Search and Select”-Component is considered as a very essential component to select the data and to have a meaningful subset of the data. The handling of the component is evaluated as very intuitive and straight-forward. The filter possibilities are liked very much.

In addition to the high ratings for the components’ usefulness and the clear purpose of the component, its ease of use is (slightly) positively rated by each HWU/SAS-test person. On the other hand, the INN-test persons rate the ease of use slightly negative. We assume that this is due to the fact that some of the users are familiar with similar faceted-search-frontends from other applications.² This can be seen from the ratings for the question “I have similar functionalities in the tools I currently use”. In total, understanding this question to indicate how novel the component is, the novelty is in average quite neutrally rated. But it should be noted that (apart from one n/a), each single rating has a clear tendency. That is, this type of interface seems to be well known by some users, as they agree to have similar features in existing tools, whereas other users have not seen similar functionalities yet.

Going into more details of the interviews of the component, please note that the table view is preferred to the list view by all users who mentioned this point (the list view is even considered by some as unnecessary). A positive feature of the component is that the actual queries are stored in the URL, i.e. queries can be bookmarked. This is mentioned as an useful additional feature. Finally, some users proposed possible improvements of the component in the future:

- Showing actual minimum and maximum values in the filter ranges;
- Adding a “select all” option in the filter;
- Distinction between selected and not selected parameters; and
- Greying out facets with no data.

Summary: “Search and Select” is considered useful and important, but for some users, it is not considered very novel. Storing queries in URLs is helpful. There are concrete tips on how to still improve the interface.

Conclusion: The evaluation shows that faceted search frontends should be used in BI-solutions, and it gives clear hints on what kind of features the user consider helpful and important.

”

² E.g. most popular shopping-pages like amazon.com or ebay.com use faceted navigation.



For the "Search and Select" Component	With Innovantage		Without Innovantage			
The purpose and function of the component is clear.		6		4	0,56	0,75
The component is easy to understand and use.		6		4	0,28	0,58
The interface is appealing and attractive.		6		4	-0,06	0,42
The component is useful.		6		4	0,89	0,83
For some kinds of information needs or queries, particularly this component is useful.		6		4	0,72	0,75
I have similar functionalities in the tools I usually use.		5		3	0,20	-0,11

Fig 8: Search and Select: Rating Overview

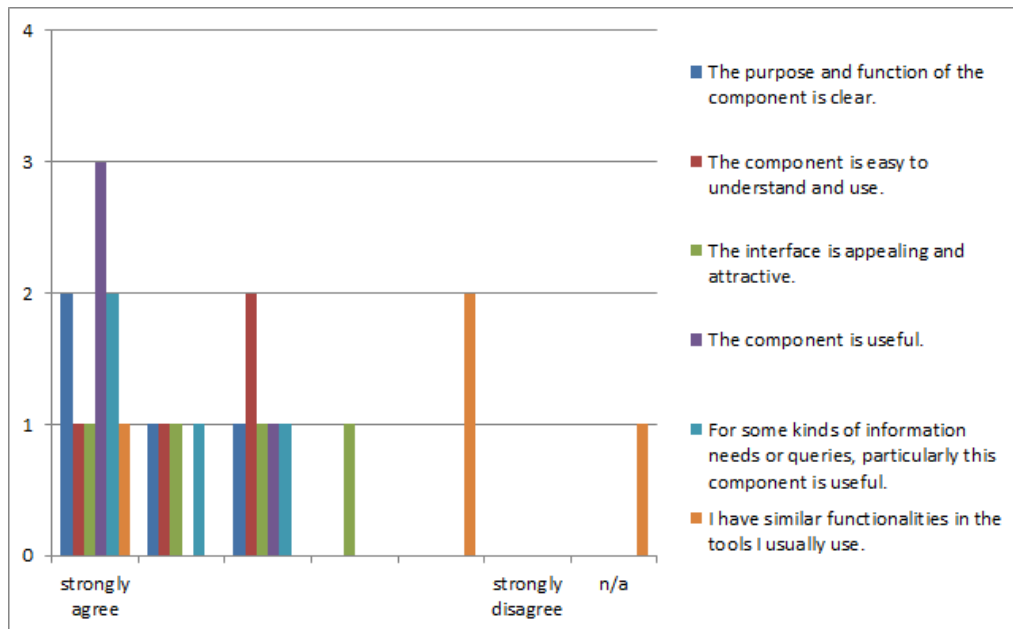
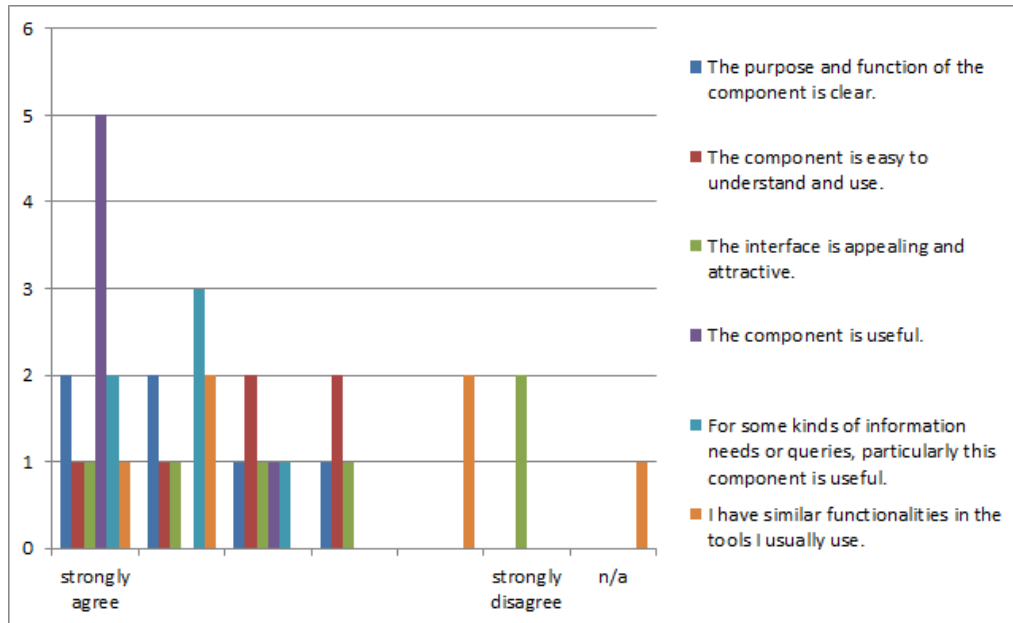


Fig 9: Ratings for "Search and Select", with Innovantage (above) and without (below)



4.2.2 Findings for the “Navigate in the Data” Component

In contrast to the “Search and Select”-component, this component is only rated by few persons, namely the two test users from HWU³. Even worse, in addition to the low number of test users: In the questionnaires, many questions (about half of them) have been answered by “n/a”, and the interviews do not provide detailed answers about this component (only one test user mentioned that this is a nice but not really necessary add-on). On the one hand, this renders the results of this component’s evaluation disputable. In the other hand, the low interest of the test users in this component already indicates that this component is not considered too helpful or even important to conduct the (user specified) test tasks.

For the questionnaire questions which have been answered, most of them are answered with +1/3, thus in total, this component is -to some extent- slightly positively rated. But on the other hand, the test users do not consider the component very novel.

Summary: “Navigate in Data” has only considered by few test users, and it is slightly positively rated.

Conclusion: The evaluation shows that the functionality of this component is not needed in future BI-solutions.

³ Thus for this component, strictly speaking the provision of two charts (one with INN, one without INN) is not needed. We only provide still both charts to keep the format of this component’s evaluation in line with the evaluations of the other components.



For the „Navigate in Data“-Component	With Innovantage			Without Innovantage		
The purpose and function of the component is clear.	■	2	0,33	■	2	0,33
The component is easy to understand and use.	■	2	0,33	■	2	0,33
The interface is appealing and attractive.	■ ■	2	0,50	■ ■	2	0,50
The component is useful.	■	2	0,33	■	2	0,33
For some kinds of information needs or queries, particularly this component is useful.	■	2	0,33	■	2	0,33
I have similar functionalities in the tools I usually use.	■	1	0,67	■	1	0,67

Fig 10: Navigate in Data: Rating Overview

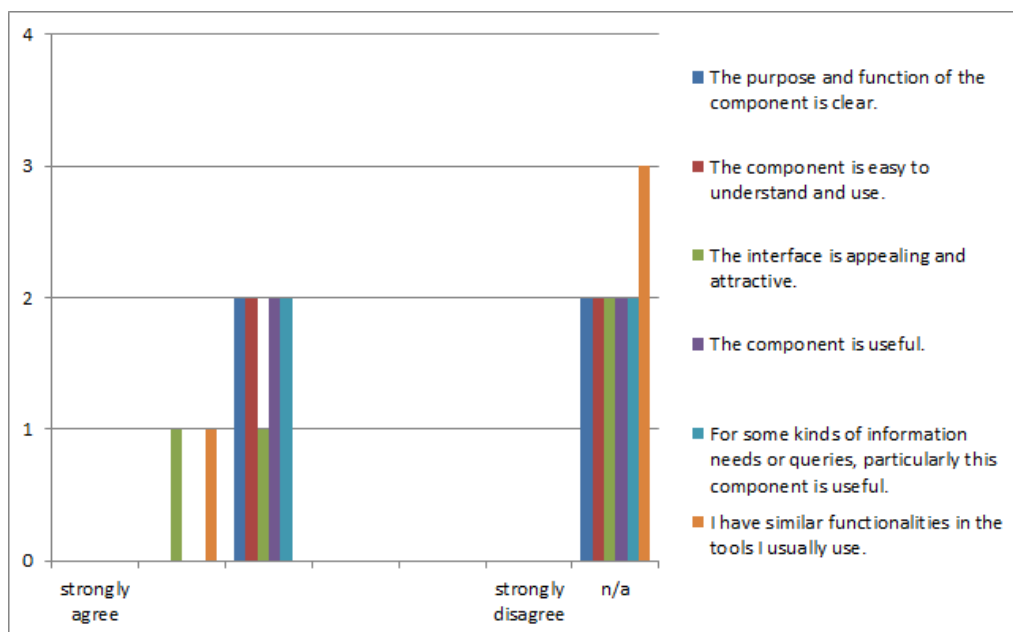
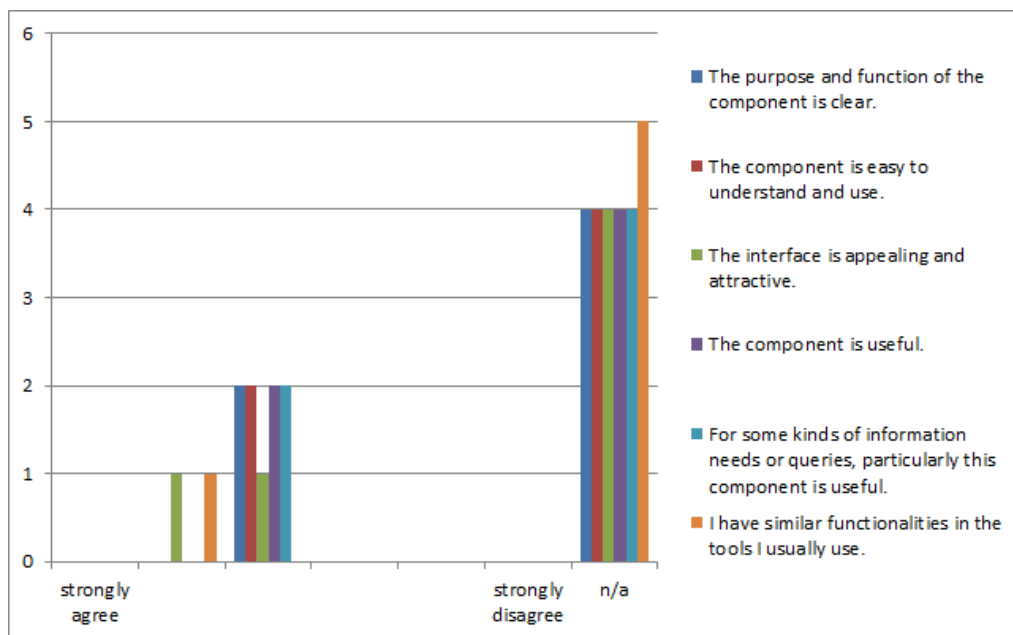


Fig 11: Ratings for “Navigate in Data”, with Innovantage (above) and without (below)



4.2.3 Findings for the “Explore Selection” Component

The “Explore Selection”-component allows to interactively explore (by means of a node-link-diagram) the information space, utilizing the semantic relationships between different classes (aka facets) of entities. As there is only one class in the SAS use case (and thus no semantic relationships between different classes), this component is of no use for SAS and has thus been dropped from the SAS-use case prototype. For this reason, only the HWU/INN test users evaluated this component. The two SAS test users assigned “n/a” to each according question in the questionnaire. Contrasting the SAS test users, amongst the other four test users only one user assigned to one question an “n/a”. We have for four users a (nearly) completely filled questionnaire.

First of all, with an average rating of 0.67 for both questions “the component is useful” and “the component is useful for some information needs”, this component turned out to be quite useful for the test users (even for the users from INN). To provide more details from the interviews: one of the INN users mentioned that the component is very useful e.g. to drill down more specifically into attributes. This user would like to have more explanation of the functionalities and better implemented zoom functionality, and a selection possibility for different visualization styles would also be useful.

With an average rating of 0.50 (for HWU/ INN), the purpose of the component is clear for the test users as well.

Importantly, this component is considered very novel by one HWU person, namely the chief editor of EMAGE, and slightly novel (rating 1/3) by the two INN test users. That is, the component is novel.

The interface, though, raised some controversial voices: It got rated very good respectively fairly good by the HWU test users, but it was negatively rated by both INN test users.

Summary: “Explore Selection” is an innovative component which is considered to be useful and to have a clear purpose. The test users disagree in its ease of use.

Conclusion: Future BI solutions which aim at providing means to explore the data should incorporate functionalities which resemble the functionalities of the “Explore Selection” Component. Designing the interface for such exploration means deserves closer attention.



For the "Explore Selection" Component	With Innovantage		Without Innovantage	
The purpose and function of the component is clear.	4	0,50	2	0,67
The component is easy to understand and use.	4	0,50	2	0,67
The interface is appealing and attractive.	4	0,17	2	0,67
The component is useful.	4	0,67	2	0,67
For some kinds of information needs or queries, particularly this component is useful.	4	0,67	2	0,67
I have similar functionalities in the tools I usually use.	3	-0,56	1	-1,00

Fig 12: Explore Selection: Rating Overview

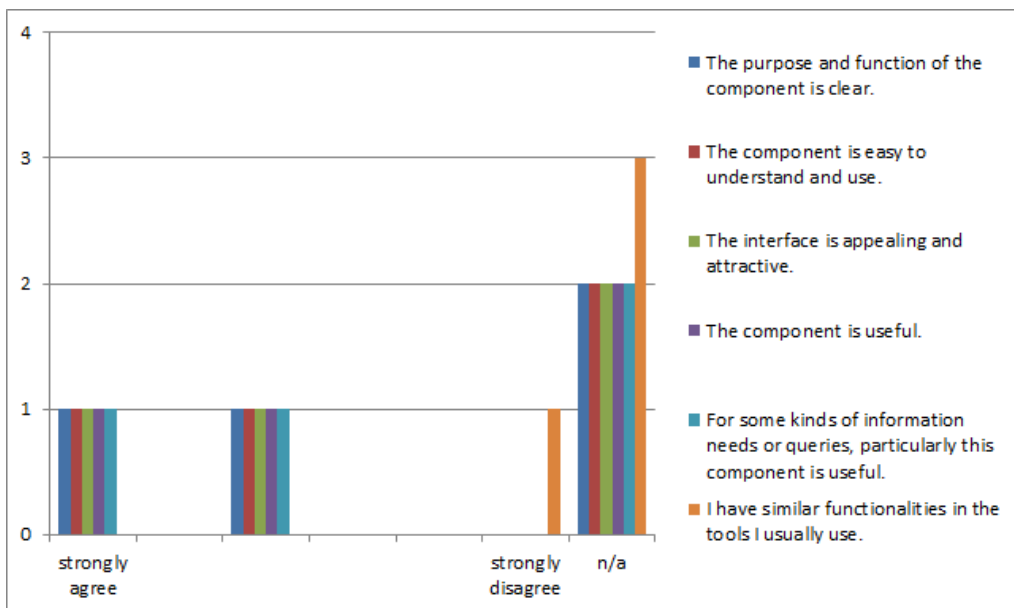
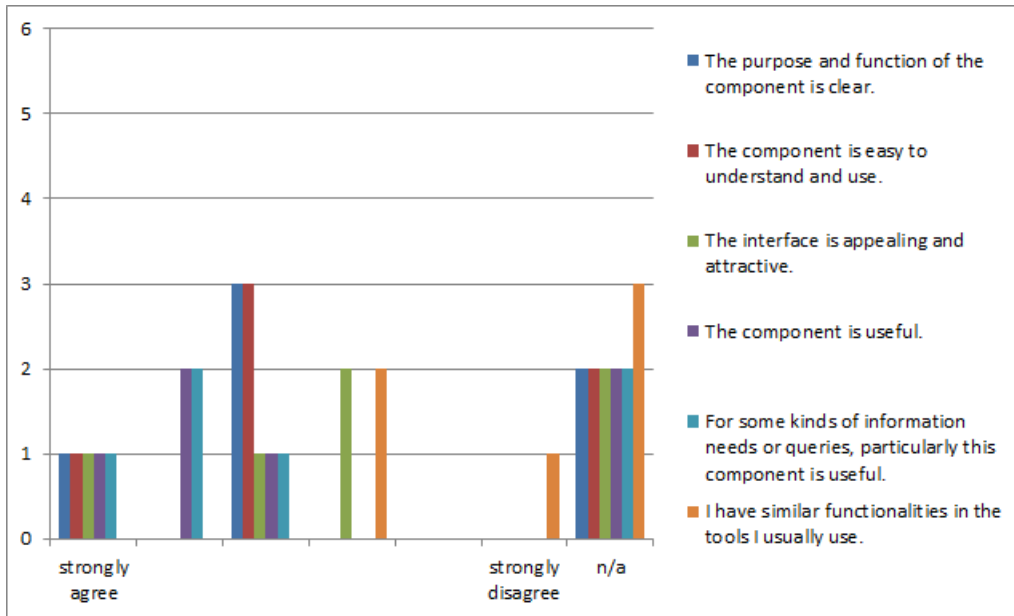


Fig 13: Ratings for "Explore Selection", with Innovantage (above) and without (below)



4.2.4 Findings for the “Analyse Selection” Component

The novel visualization capabilities belong to the core of the CUBIST research project. For this reason, in addition to the six questions posed for each component, the questionnaire comprises for this component four additional questions which allow to evaluate the Visual Analytics capabilities of CUBIST in more detail. This component has been evaluated by all test users.

Standard questions:

First of all and as expected, with an average of 0.33 for HWU/SAS/INN and even 0.5 for HWU/SAS, this component turned out to be useful for the test users. As it can be concluded from the interviews, the component is considered to be especially useful for discovering relationships, see differences and unusual things.

The purpose of the component is rather clear to the test users. Comparing the use cases, it is less clear for the INN-users (in comparison to the HWU/SAS-users). This might be caused by the fact that for the tasks in the INN-use case, traditional BI-means are more appropriate than the novel means provided by CUBIST, whereas for the task in the other two use cases, traditional BI means fall short.

The component is generally rated very novel. Four out of six users have given ratings, two of them with a rating of 1 (strongly disagree) to the question “I have similar functionalities in the tools I currently use”, and one with a rating of 0.67. There is, though, one notable exception: The fourth user, being an INN user, rated this question 1, i.e. he strongly agrees to having similar functionalities. We consider this very surprising rating a “drop-out” or mistake, as a matter of fact no current commercial Visual Analytics tools provide FCA-based visualizations.

The component has a clear usability issue: With nearly identical results for HWU/SAS and HWU/SAS /INN, the component is in average negatively rated with respect to its ease of use (with an average of -0.27 across all use cases). The attractiveness of the interface is not too well rated as well.

The integration of different visualizations was helpful for fulfilling my task.

Summary: “Analyse Selection” is an innovative component which is considered to be useful and to have a clear purpose, but the component has a usability-issue.

Conclusion: It is reasonable that future BI solutions which aim to extend their Visual Analytics capabilities should incorporate functionalities which resemble the functionalities of the “Analyse Selection” Component. But before doing so, the interface has to be strongly redesigned in order to improve the ease of use.

A more detailed summary and conclusion for the Visual Analytics functionalities is given below.

Additional Questions:

The questionnaire contains for additional questions dedicated to the Visual Analytics features of CUBIST. A first glance shows that the answers are rather scattered those questions.

The first question “the visualizations were easy to understand” does not target the ease of use of the component as such, but addresses the novel visualizations more directly. The evaluation shows a very light, negative tendency. But as the interviews show, the users see a clear pay-off of the not-so-easy-to-understand visualisations. One user states that

It took me a little while to understand the graphs (the Hasse-diagrams) [...]. The Hasse-diagrams made more sense to me compared to the alternative visualisations.

and another



I'm a big fan of Formal Concept Analysis, and the lattice visualization. Cross comparison is also great. [...] I am really a fan of the Hasse diagram but others, such as Sunburst or Sankey are not very meaningful for me. Also the matrix visualization can be very useful.

Both the next question “There are visualizations available that did fit my tasks very well” and “The integration of different visualizations was helpful for fulfilling my task” are positively rated. A working hypothesis of CUBIST is the assumption that considering different classes of visualizations (traditional BI-visualizations like bar charts or pie charts, graph-based visualizations like node-link-diagrams, and even FCA-based visualizations), none of the classes supersede another one, but instead, they satisfy different kind of information needs and are thus complementing. In CUBIST, those different classes are implemented. The answers to the two questions show that the CUBIST-approach to provide different types of Visual Analytics, which are not acting “side-by-side”, but which are integrated, pays off.

The result of the last question “It is clear how the different visualization interact “ shows a very light, negative tendency. To some extent, this narrows the positive conclusion of the last paragraph. In CUBIST, sometimes different visualizations interact via linking-and-brushing, or some visualizations can be created on the dataset shown in other visualizations. Even though that integrating different visualizations as such is positively rated, the negative answer to the last question shows that *how* such an integration is done is a non-trivial issue.

The interviews provide more details on the pros and cons of different visualization means and their interactions. The CUBIX is considered as a useful part of the system, especially the filter functionality was praised. The visualizations are considered as promising, interesting but also difficult to understand e.g. there are too many options at once. As the above quotations already show, the users are particularly fine with the Hasse-diagrams, but the combination with other visualizations like sunburst or bar charts (for distribution) is not considered as very valuable. For the Hasse-diagrams (and partly for other visualizations), the users have clear recommendations on how to improve them. The users proposed to improve the zooming functionality like a ‘Google hand’ (like with Google maps), to implement a clearer labelling, to improve the readability especially for large data sets and to adjust the position of the popup window. Moreover, in terms of functionality, the users would also like to have functionality for adding and removing attributes from the lattice and an overview of selected ranges.

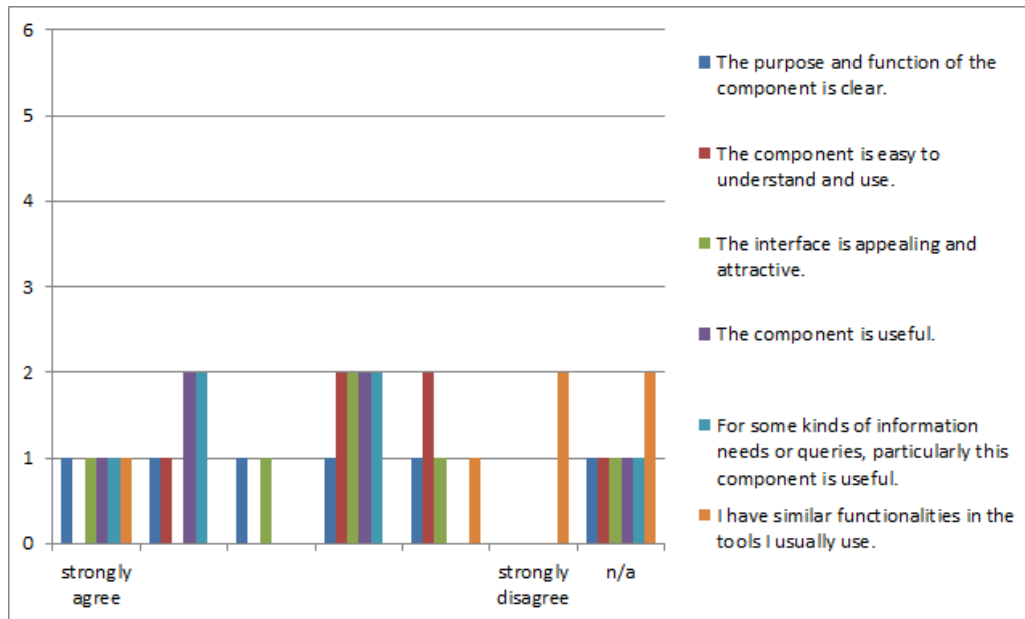
Summary: The evaluation shows that the integration of complementing types of visualisations in one BI-tool is positively rated by the users. This applies even to diagrams which are in the beginning hard to understand: somewhat surprising, particularly Hasse-diagrams are appraised by the test users in the evaluation. But the evaluation shows as well that a tool must not be crowded with visualizations or options, and that the way how different visualisations interact is in CUBIST not to well solved.

Conclusion: The evaluation supports the CUBIST working hypothesis that the integration of complementing types of visualisations in one BI-tools is a promising path for future BI-solutions. But the evaluation shows moreover that questions like what on how visualizations are combined in one tool needs to be further investigated before the envisioned new BI-tools are mature enough.



For the "Analyse Selection"-Component	With Innovantage			Without Innovantage		
The purpose and function of the component is clear.		5	0,20		4	0,42
The component is easy to understand and use.		5	-0,27		4	-0,25
The interface is appealing and attractive.		5	0,00		4	0,17
The component is useful.		5	0,33		4	0,50
For some kinds of information needs or queries, particularly this component is useful.		5	0,33		4	0,50
I have similar functionalities in the tools I usually use.		4	-0,42		3	-0,89
The visualizations were easy to understand.		5	-0,07		4	-0,17
There are visualizations available that did fit my tasks very well.		4	0,42		3	0,44
The integration of different visualizations was helpful for fulfilling my task.		4	0,42		3	0,67
It is clear how the different visualization interact.		5	-0,13		4	-0,08

Fig 14: Analyse Selection: Rating Overview



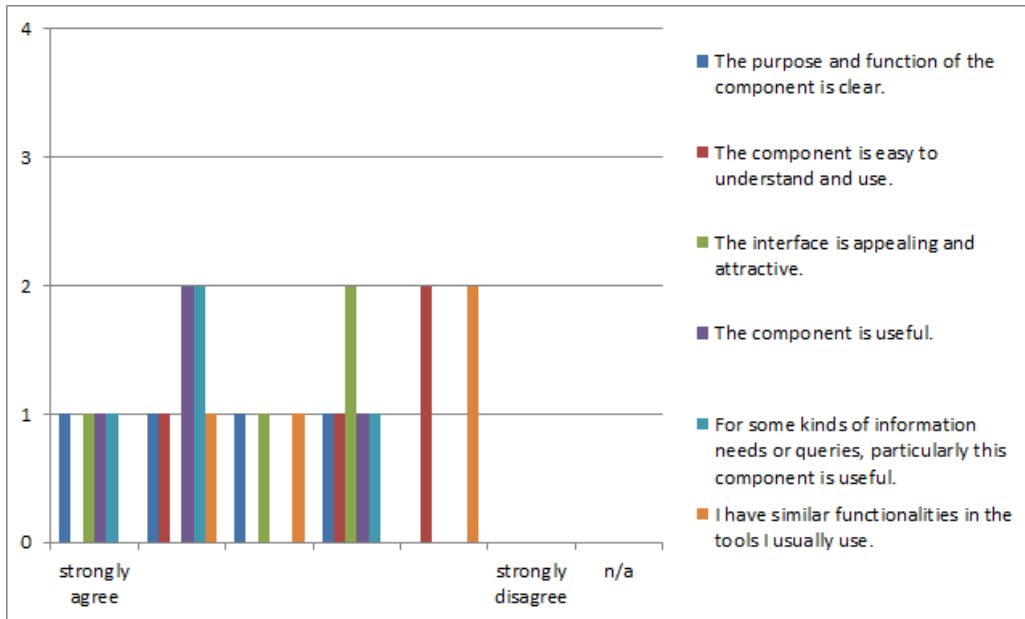
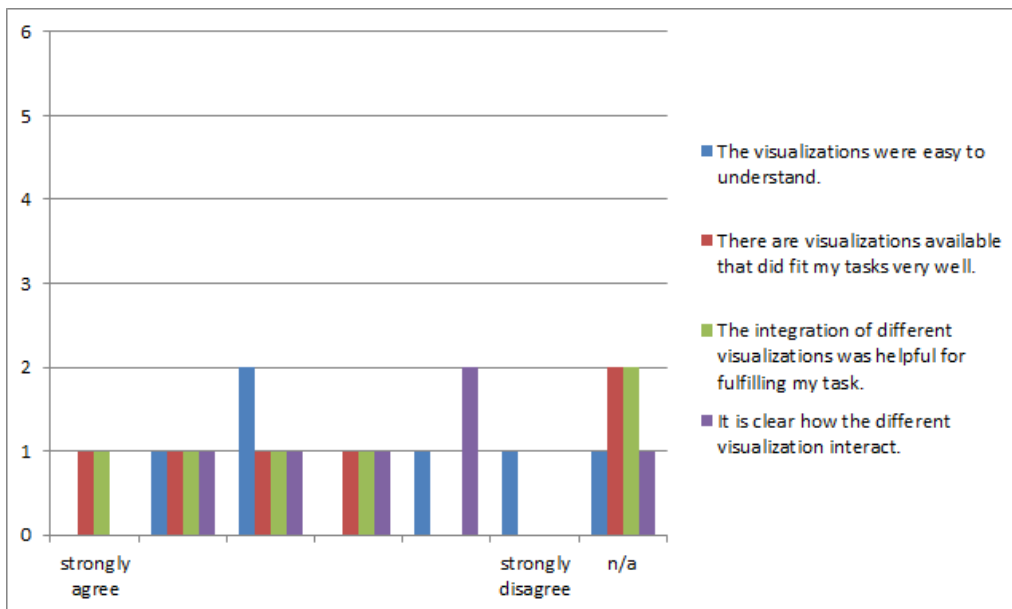


Fig 15: Analyse Selection: with Innovantage (above) and without (below)





<Confidential>

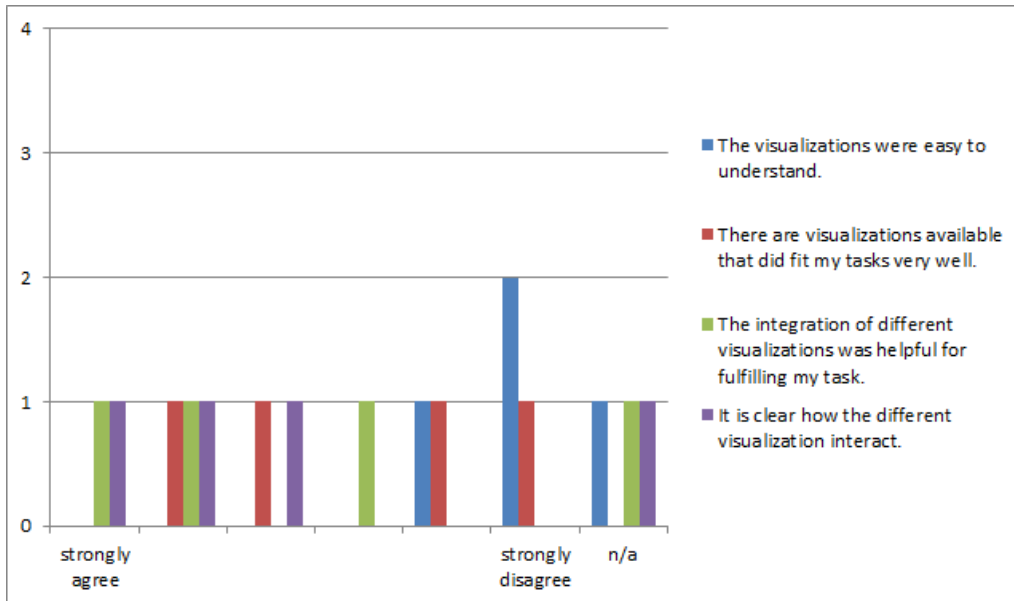


Fig 16: Analyse Selection: Additional Questions with Innovantage (above) and without (below)



5 Summary and Proposed Future Improvements

From a user's point of view, the following two features are essential:

- 1) CUBIST provides components which support factual search ("Search & Select"), explorative search ("Navigate in Data", "Explore Selection) and visual analytics features ("Analyse Selection").
- 2) The component of CUBIST in turn features different types of Visual Analytics means, like traditional BI visualizations (bar charts), novel tree-based visualizations (e.g. sunburst diagrams), FCA- and graph-based diagrams (e.g. the Hasse Diagrams), which are interlinked and highly interactive.

For this reason, the evaluation focused not only on evaluating the overall prototype, but it evaluated the different components separately (with an emphasis on the "Analyse Selection" component) and their integration in the prototype.

During the evaluation, the users had to walk through a set of use-case-specific tasks. Then we used interviews for gathering qualitative information and questionnaires for gathering quantitative information from the users. For each part of the evaluation (evaluation of the overall prototype, evaluation of the integration of the different components, evaluation per component) we provided in the previous section a short summary and conclusion.

In this final chapter, an overall evaluation summary is given. Based on the conclusions of the evaluation, we propose possible improvements of future BI tools.

First of all it has to be noted that CUBIST is perceived an *expert tool* by the users. It targets experts for a given domain of discourse who

- 1) Have specific information needs and who need some sort of in-depth analysis of their data
- 2) who have enough skills and time resources to familiarize with the novel and sophisticated Visual Analytics means in CUBIST.

Thus the recommendations provided in this section should be understood to target BI tools for experts, not tools for casual BI users. Moreover, the recommendation target future BI-tools which aim at addressing information needs which go beyond those needs which can already be addressed by traditional tools.

First of all, the evaluation shows that different tasks (with different information needs) in different use cases and require different means in a tool to meet them. Apart from the "Navigate in Data" component, each component is considered useful for some information needs. The evaluation shows that the integration of components which support factual search, explorative search and Visual Analytics pays off. The evaluation shows furthermore that in CUBIST, from a usability point of view, integrating different components and visualizations is challenging.

Proposed recommendation 1: Future BI tools should not only focus on the analysis (in the BI understanding) of data, but on the search in data and the exploration of data as well. Integrating different components which target different information needs is challenging and needs further investigations.

The "Search and Select" component uses a faceted search approach to search for and filter the data. Faceted search frontend are meanwhile quite common, and unsurprisingly, the users do not consider this component very novel, but easy to use. Moreover, this component is considered the most useful one in CUBIST, and it is understood to be the entry point for all further activities in CUBIST. Note finally that the filtering-facilities of this component are appraised by the users, though users had concrete recommendation on how this component can be improved.



Proposed recommendation 2: It is very reasonable to have faceted search based frontend in future BI-solutions for searching and filtering the data. The evaluation gives clear hints on which filtering functionalities are requested by the users.

The “Explore Selection” component is considered innovative and useful, and it has a clear purpose. The test users disagree in its ease of use. The conclusion of serves as our next recommendation:

Proposed recommendation 3: Future BI solutions, which aim at providing means to explore the data, should incorporate functionalities which resemble the functionalities of the “Explore Selection” Component. Designing the interface for such exploration means deserves closer attention.

Finally, we consider the Visual Analytics features of CUBIST. Next, we summarize those features and provide corresponding recommendations.

CUBIST features a variety of novel visualisations (sunburst, sankey, matrix...), combined with relatively simple, traditional visualizations (bar chart, pie charts). The novel visualisation features are a clearly dominant feature of the “Analyse Selection” component, and they target different information needs as satisfied by traditional BI tools. They complement traditional BI: CUBIST is strong when it comes to finding clusters and relations in the data, but is not well suited for traditional BI use cases. Having different types of visualisations integrated in one BI-tool is positively rated, even if some visualisations are in the beginning hard to understand. Surprisingly, particularly Hasse-diagrams are appraised by the test users.

The evaluation showed clear downsides of the “Visual Analytics” component as well. Its ease of use, appeal and attractiveness are badly rated. Some reasons for these bad ratings can be found in the interviews: The component is too crowded with visualizations or options, and the way how different visualisations interact is in CUBIST not well solved.

This leads after all to the final recommendation:

Proposed recommendation 4: Future BI-tools should comprise quite different Visual Analytics means, ranging from traditional to novel ones (e.g. graph-based). One should not hesitate to include unfamiliar, sophisticated visualizations into expert BI tools, even if those visualizations are not ease to digest from the very beginning.

Care has to be taken on how in such future tools different components and visualizations are integrated and how they interact, and further research on how one can integrate different information access means in one tool in a user-friendly, understandable way.




<Confidential>



6 Appendix

Here you can find some additional files used for the data analysis:

File	Description
 CUBIST_Interview_R esults.xlsx	Interview Results Analysis