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Best-Practice Piloting of Integrated Social Media Analysis Solution for E-Participation in Cities

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Abstract

Goal definitions and developments are challenging in large-scale projects, because of the different expertise and skills of the stakeholders. Development often fails its intended goal because of misunderstandings and unclear definitions and descriptions during the planning phase. The paper describes a novel approach to collecting requirements and defining development plans by provisioning a guideline which informs what has to be done, when and in what form. The User Case Requirement Analysis model was applied in the large-scale European project FUPOL during the development of a Social Media Analysis System. Based on this a successful task-based evaluation could be performed that shows the benefit of the model and the software.

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1. Introduction

E-Government and the engagement of citizens in politics are on the agenda in many countries[1, 2]. Therefore, a number of projects and programs were initiated that aim to find creative and effective solutions for involving citizens. One intended aspect is the provision of transparency[3], e.g. through (Open-) Data provision that enables citizens to analyse indicators of a country, state, province or local region. A further step is to consider citizens'

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opinions in the policy making process. In many countries petitions are one option to bring an important issues (from the citizens' point of view) on the political agenda. Unfortunately this will only be possible, if a significant number of citizens are engaged and support such an action. Even more, it is not realistic that each issue, in particular on a municipality level, can be clarified by citizens via petitions.

A modern approach to support politicians in recognizing citizen opinions is by using ICT. The growth and establishment of social media allow most people to discuss political ideas and critics virtually. These discussions can be observed and analysed by technical systems to present the major points in a summarized manner to the decision makers. However, this intention works often only in theory, if such approaches will be discussed with political and authority representatives the goal definition and what functions are required is difficult. The major barriers are the different topical languages and the role of representatives. The result is often an extensive discussion consisting of political terms by the politicians, officials by members of authorities, technical vocabularies by the technicians and scientific keywords by researchers.

In this paper we introduce a best-practice piloting approach for discussing and realizing innovative solutions with a variety of stakeholders from different domains. The core of this paper is to show how to deal and manage the different perspectives of such an innovation development process, to develop a common set of requirements and a procedure to realize innovation that satisfies the intentions of all stakeholders. The methodology is practically and beneficially applied in two large-scale projects (on a national and international level). Therefore, we describe the methodology and its phases. Furthermore, we describe how the methodology was practically used in our last social media integration solution in the FUPOL European research project. The result is a guide or small handbook on how to achieve good results in large-projects with heterogeneous stakeholders.

2. A new Integrated Approach for Social Media Analysis

To face the challenge of a novel social media analysis approach and the required sustainability for public authorities that need to work with the resulting ICT solution, this chapter describes our approach of an integrated social media analysis solution. It consists of three major technologies that work together: the FUPOL Core Platform, the Hot Topic Sensing and the visualization of the user-interface the end users should work with.

2.1. Overall Structure and Architecture

The major difference compared to most other available social media systems is the modular structure[4, 5, 6]. The whole system consists of several modules or rather plugins that can be replaced or extended by new modules (Fig. 1). Therefore, it is not a complete proprietary system that is limiting the functions a single enterprise has implemented. Even more, the APIs allow to connect modules provided by other organizations that have more experience in a certain domains, e.g. in visualization. The result of such an open architecture approach is the ability to implement the most beneficial modules for a certain task and hence get a more productive system the user can work with.

2.2. Crawling Social Media Content

The first step of processing social media data the crawling. For this purpose the user has previously defined a so called campaign and to such a campaign he aligned a number of social media channels. A social media channel is, for instance, a specific user page, a social media page or an RSS feed. The idea is the specific observation of certain sources. This is essential because especially on a city level there are just a small number of well-known virtual discussion places of politically engaged citizens, as for instance the twitter channel of local opinion leaders or discussions of citizens on digital articles of local newspaper websites.

To crawl the content, we can distinguish between two types of connectors. The generic and the specific connectors. The generic connectors can be used for multiple sources, as for instance an RSS connector. With this connector various kinds of sources, which are often provided on websites, can be crawled without making changes to the connector. The disadvantage of this type of crawler is the limitation. The crawled source strongly depends on what data is provided via RSS, this can include, e.g. the title, description, backlinks and comments of an article, but it is not obligatory. Furthermore, many newspaper pages reduce the text to the first few sentences. To get the full range of available data, specific connectors are needed that only work so far for a single source. The task of such a specific connector is to get as much data as available from a single data source. It makes sense to use a specific connector for big services like Twitter, Facebook or a certain blog engine. Such connectors are often able to grab the full text content, and even more meta-information, for instance, corresponding likes, shares and comments. Because specific connectors are time consuming to code (also later when the connectors need to be maintained, because of API changes over time), it has to be determined for what source the effort is beneficial and for which the generic connectors are adequate enough.

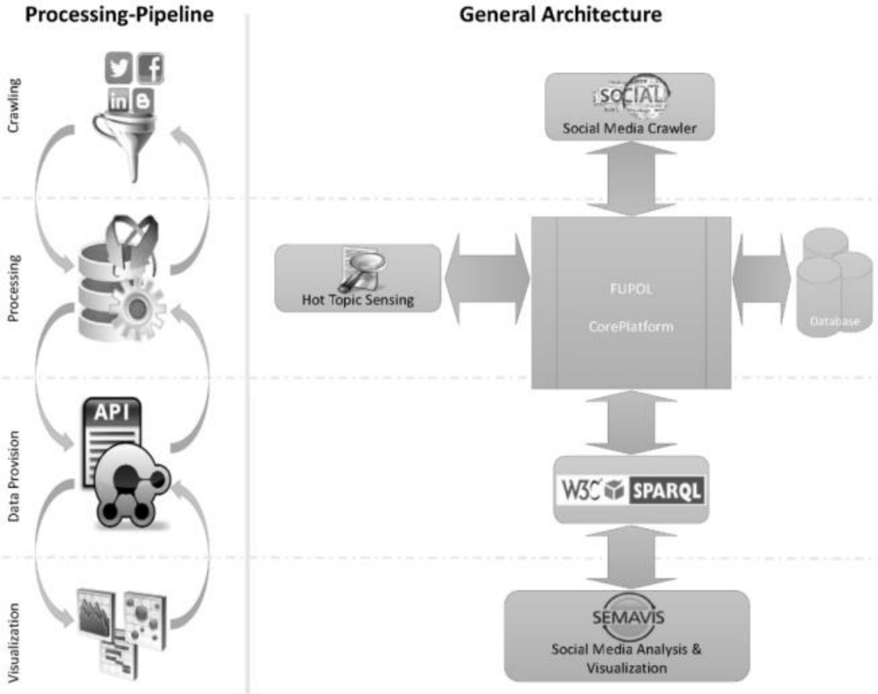

Fig. 1. Overview-to-Detail approach for the visualization interaction in Social Media Data

As result of the crawling phase all postings from the mentioned sources were crawled and cached for the following text mining phase. Next to the specific contents, additional information is also stored. For instance the number of likes, written comments etc. Critical data, e.g. the user names and profiles, are anonymized to ensure data privacy.

2.3. Data Processing and Management

Data processing currently consists of three steps. The first step is the hot topic sensing. Based on all the available postings to a certain campaign, topics are automatically generated by using LDA algorithms[7]. These topics represent a kind of categorization to allow later filtering for analysis (urban planning, waste management, public relation). Because LDA algorithm generating topics are just based on extracted keywords, the resulting topics are less human readable. To provide better readability, the system can be improved by defining so called categories. A category is an aggregation of many topics, which the user has to align manually. The result is in best case a hierarchy of humanly understandable categories to which topics are assigned and represent a bunch of postings.

The second step is semantification of the available data. To structure the data, a defined ontology is used, but with usage of already existing namespace definitions[6]. It considers a number of features - among others, the categories, the topics, the postings and the authors (Fig. 2).

The third step is the persistence of the generated data in a relational database. Based on the basic features of the ontology, all entities of the ontology are stored in the database in a relational schema.

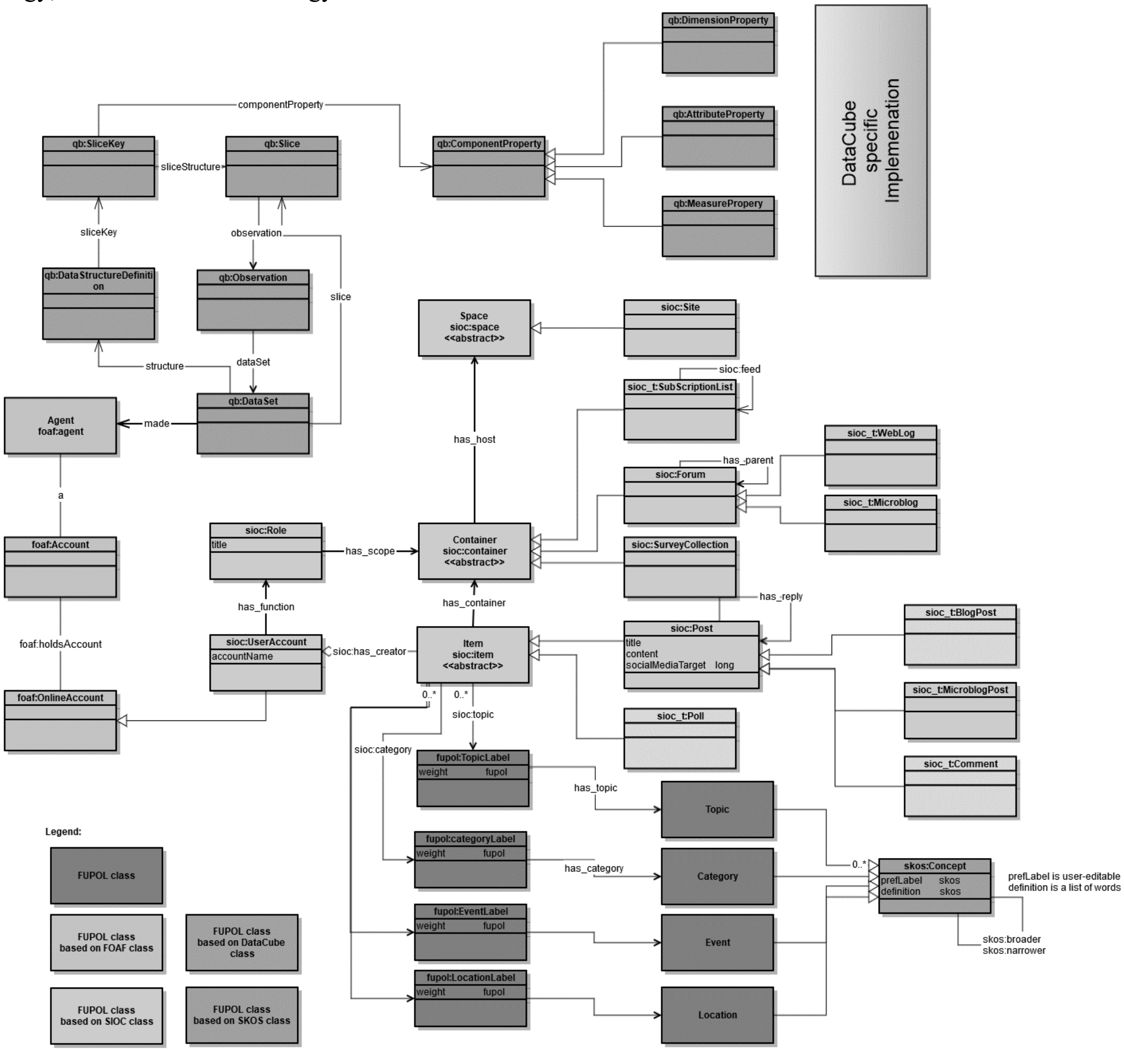

Fig. 2. The FUPOL Social Media Ontology to organize and structure the social media information (related to Rumm et al.[6])

2.4. 2.4. Social Media Visualization and Analysis

The main challenge of visualizing the social data for analysis purposes is the mass of instances in the described semantic representation. We have elaborated two ideas of partner technologies to face this problem on data level, but besides a solution to reduce the amount of instances per class/concept, the challenge of visualizing large amounts of data still remains. An adequate way of facing this challenge on the visualization level is the appliance of Shneiderman's Information Seeking Mantra[11]. Shneiderman proposed a three-level seeking mantra containing the following steps: overview first, zoom and then filter details-on-demand (see also Fig. 3). In the context of visualizing social information, the overview aspect plays a key role.[9, 10, 8] In particular, in the context of social data visualization we identify three main views on the information level:

- Overview on categorical level
- Overview on temporal level

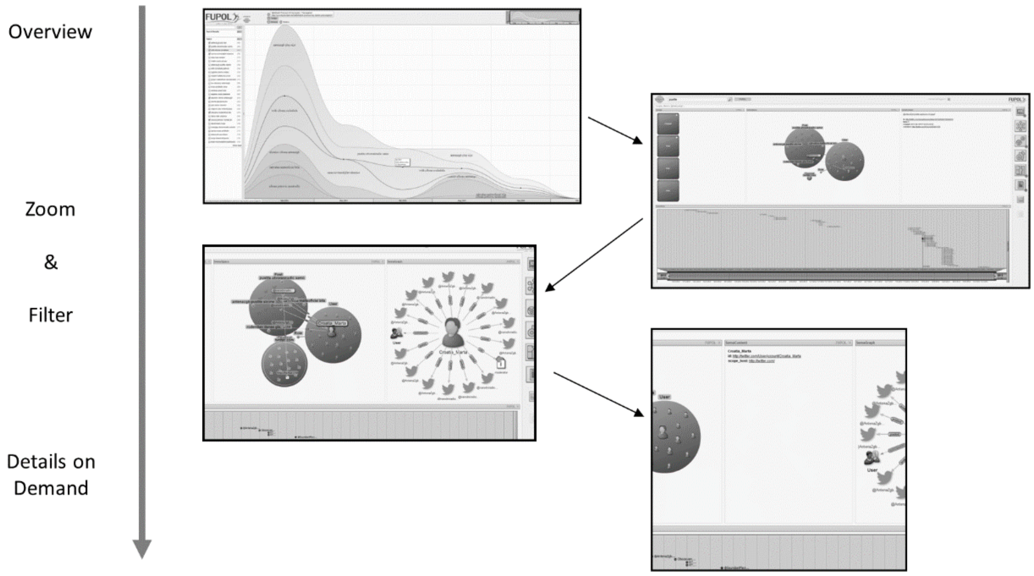

Fig. 3. Overview-to-Detail approach for the visualization interaction in Social Media Data

The visualisation overview levels are not distinct and can be combined to view different information aspects.

The thematic arrangement enables a visual overview definition of "categories-of-interest". The composed set of visualizations allows sifting through the data interactively. The computed category/topic/post relevance by the hot topic sensing technology and the result of a quantitative analysis are considered per the user request on the server's side. The different informational requirements are then visualized on the presentation level by using the visual variables. The size of a graphical entities will provide quantitative information whereas the relevance is visualized by their colour.

The first categorical visualization provided is a so called ThemeRiver[13], which visualizes the topics and then weighs them over time. This visualization addresses both of the above mentioned information levels:

(1) The categorical level, and
(2) The temporal level.

At this stage, the user can analyse upcoming relevant topics as well as important topics. By selecting a topic, the user filters the data significantly. By visualizing the temporal overview and providing a margin in time, another dimension of the data is investigated. We propose that the temporal view is the most beneficial way to:

- View the trend of upcoming social opinions
- Interact with and filter semantic data for relevant topics based on time

Here, we propose the use of a stacked graph by using the following informational requirements on the information dimensions:

- Size: quantity of topics, terms or extracted features
- Colour: relevance based on the computed relevance by Hot Topic Sensing technology
- X-Axis: temporal spread

The second categorical visualization provided is a hierarchical tree map that uses the thematic hierarchy of the ontology as one visual indicator, the relevance of the topics as another and the size as a third indicator for providing an overview of a topic on the category level. The parameters are abstracted to the highest level. The hierarchy is simplified and visualized as overlapping (superimposing) and integrating spatial spaces. The size illustrates the quantity and the colour the relevance:

In contrast to that very simple visual view, a graph-based layout will be integrated that targets the same information values. Therefore the size of the circle will be used as an indicator for the quantity of information in one category, the hierarchy will be displayed as smaller integrated circles, and the colour will be used for the computed relevance. We are dismissing any semantic relationships in this view, so to not confuse the user with too much information.

Next to the categorical filtering, also a mechanism for temporal filtering is provided. The timeline visualization SemaTime serves this purpose. Through an enlargement of the timeframe at the bottom of the SemaTime, the timeline-based visualization, the time range can be increased and following posts will be filtered or further postings will be retrieved.

The next step after the overview is a more detailed view with relational information. Therefore the existing graph-based visualizations will be extended to visualize the dependencies between actors and topics, between actors themselves and between topics themselves. This step can be done after refining the overview visualization or based on a specific search that contains a comprehensible number of entities.

We propose to use a force-directed visual graph algorithm with quantitative analysis for this issue. In this case the size of a circle indicates the number of entities, the colour the relevance, the size of entities the number and/or relevance of a topic or actor himself and the relations the semantic relationship design in the FUPOL social data ontology.

The detailed visualizations can further provide more information by requesting more details on demand. If for instance an author icon has a greater size than another, we can assume that this person is an opinion maker, because either he has many postings or the postings are read by many people (regarding the underlying data and goal). By clicking on this actor the visual representation will first give more information about him and further detailed information (as far as available) about the person will be provided.

3. Piloting and Establishing Social Media Analysis in Cities

The deployment of new ICT in public authorities is challenging, because of high requirements regarding stability, usability and expected benefit of a new system. One of the reasons is that public authorities need systems that do not limit productivity, since they have to follow strict workflows. To consider these specific behaviours and requirements, it was essential to stay in contact with those experts and define a clear procedure on how to proceed and what aspects are necessary.

3.1. Finding a common Language: Technicians vs. Politicians and Policy Experts

The very first important issue was finding a common language. This aspect sounds easier than it really is. Researchers and technicians have mostly a limited view and speech that is oriented on the technical or political/administrative profession and skills. Technicians, for instance, consider political aspects only in a limited way (this should not mean that these aspects are neglected overall). On the other hand the employees of public authorities have a less technical background, in particular in regards to research and development. They know their tasks and what tools they currently use to solve these tasks. To define a common development roadmap it is essential to understand the conditions of both sides. Therefore it is essential to communicate the conditions, restrictions and plans to the other side and vice versa.

To achieve a common language, it is often beneficial to explain features in forms of stories and maybe on the hand of existing or currently used software. Talking about features, algorithms or requirements is in contrast less helpful, because each stakeholder imagines often what he “understands” under these aspects. If something is explained to the end users, GUI-mock-ups or screenshots can also help. However, end users should also trust the UI experts and developers. Because often most computer users think they know how to design a good user-interface, but the topic is more serious than it seems. The user-interface should be discussed in a major way based on stories, to avoid semi-technical discussions that lead to unsatisfying plans and results for technicians and end users.

3.2. Multi-User Requirements Analysis

If both sides are willing and also a common understanding and language is found, it is essential to define a roadmap for getting from visions to a sketch and finally to a solution. In FUPOL we used a defined requirement analysis process for the Use-Case Requirement (UCR) Analysis, as depicted in Fig. 4, which covers all relevant parts to find a common agreement and at the end a successful solution. The procedure allowed for an efficient analysis of the requirements and even more important, an efficient creation of an implementation plan including a setup for priorities.

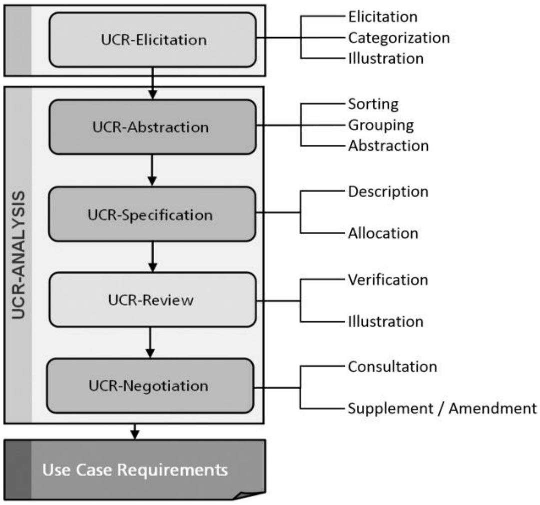

Fig. 4. Use Case Requirement Analysis Model

Overall this model can be seen as an iterative approach. After the first round of the UCR analysis and implementation of discussed features, another round can be initiated to refine and extend the system. This makes this approach also useful in large-scale projects as, for instance, in FUPOL or ther bigger projects where more than just one development iteration is intended.

One important fact is that this approach should be performed before major developments and before user related features are in progress. Basic aspects that are relevant overall, like the development of a general system body, a configuration parser etc. can be developed in anyway parallel to the UCR analysis. But in particular the graphical user-interface and some data-processing aspects should be shifted to the end of the UCR analysis.

3.3. Engaging meanwhile Software Development

Many software development cycles follow the approach of first defining the requirements and goals, in the second phase the system will be developed and in the last and third phase the system will be deployed and provided to the users. A major weak point of this approach is that misunderstandings and incorrectly implemented features can only be identified when the whole development is already done. But especially in this phase it is nearly impossible to make bigger changes without wasting large amounts of time and money. To avoid such situations, it is essential to communicate development milestones to the intended users.

To keep such communications as efficient as possible, it is important that both sides understand that this is not final software and only the relevant results should be discussed. In particular the graphical user-interface is often discussed in detailed, even if the used layouts and styles are not complete. It is important to focus on the general approach of the UI and if it corresponds to the tasks and expectation of the intended users. The general interaction metaphors and styles should be more in scope than graphical aspects.

3.4. Smart Feedback Collection for Technology Improvements

All of the previous approaches are on the planning and discussion level. However, to collect empirical information about general used metaphors or selected visualization algorithms, these approaches are limited or only offer a subjective impression. In particular if graphical visualizations are used, it will be hard to determine if the visualization really provides an added value and allows for more effective and efficient work. The subjective feedback of users offers a good orientation, but it is more pragmatic and empirical to validate this based on analysis of e.g. task completions or the used task completion time.

Currently, there are only a rare number of approaches established that allow for such analysis aspects in an efficient manner. Almost all approaches deal with local methods and do not allow to provide an evaluation via web as a distance-based evaluation. For this purpose we designed an evaluation approach to allow for distance-based evaluation over the web and collecting empirical data based on real tasks the participants (target users) have to solve.

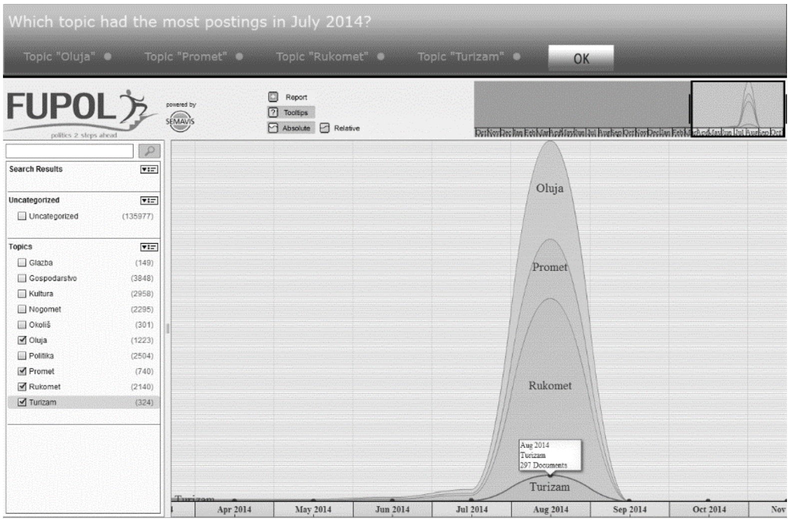

Fig. 5. Screenshot of the Evaluation system

In our designed evaluation system[12] it is possible to use classic questionnaires, e.g. to collect demographic information about the users as well as further information about his/her ICT skills. More important is the novel approach to evaluate a system in an empirical manner. Hence, the user has also to deal with the novel part of our evaluation system. He gets a number of tasks that he should answer with the system linked below (see Fig. 5). In the background the evaluation system logs task completion, the task completion time and information, on which a detailed analysis can be performed to identify gaps and aspects that should be enhanced.

In a combined view of the conventional questionnaires and the practical evaluation, it is possible to identify if the subjective perception of users is different to the objective facts that are measured practically.

4. Evaluation of Social Media Analysis in Cities

For the empirical evaluation we used the introduced evaluation system. We considered a number of conventional questionnaires and in this paper will focus only on the results of the practical part. Therefore, we measure the correctness of participant answers and the elapsed time. At this stage we did not perform a comparison evaluation (cross evaluation) with another system, because there are no real appropriate software solutions (for testing) available that provide similar functionality. However, this evaluation is nevertheless important because all participants are domain experts from pilot cities. The engagement of such domain experts, even without a comparison to other tools, shows the general usefulness and usability of our approach.

The evaluation was performed with 45 participants in total (from two different European cities). All participants had to use the same software for the same type of tasks. Only the used data was different in respect to the citizen and participant language behaviour. For each task the user had the option to give no answer (the users should also use this option if they are not really sure, if they identified the correct answer) or the expected answer.

4.1. Methodology

The general methodology is simple. The user gets the task and the web-application to solve it. For each answer approximately four answer options where given. The tasks were defined based on the work the domain experts have to do. The goal of this evaluation was to identify the sufficiency of our integrated social media analysis solution against real tasks of the pilot and target users. The defined questions are as follow (the language-dependent generic parts of the questions are highlighted in italics):

(1) How many topics are available in your campaign? (4 answer options)
(2) Which time period is covered by topic *"Oluja"* (from where the first time postings are available)? (4 answer options)
(3) In which month had topic *"Politika"* the highest number of new posts? (4 answer options)
(4) Which topic had the most postings in *July 2014*? (4 answer options)
(5) Which is the most important topic in the period *May to August 2014* in terms of number of postings? (Should be more analytical, thus 6 answer options)
(6) Which topic gained the most importance between *May and July 2014* (terms: number of postings)? (4 answer options)
(7) Which topic lost most importance between *March and May 2014* (terms: number of postings)? (4 answer options)
(8) How many postings were published for the topic *"Nogomet"* (in total)? (4 answer options)
(9) Which real user (username unequal „unknown") has the most postings regarding topic *"Glazba"*? (3 answer options)
(10) On which day were in total the most postings published to Topic *"Glazba"*? (4 answer options)
(11) How many users (including usernames equal „unknown") posted about topic *"Glazba"*? (4 answer options)
(12) From which platform would you be able to get further contact information to the User *"Jutarnji"*? (4 answer options)

4.2. Results

The results are satisfying. It can be summarized that the given tasks could be answered correctly on average 68% of the time. For more than half of the questions the correct task completion is higher than 70% (Fig. 6). The average time taken for each tasks was 83 seconds. Based on the fact that the users need time to orientate within the tool, the users required most time for task one. The average time for each task excluding task one is 68 seconds. This is overall a very good result, since the given tasks are analytical and are hard to answer without the developed solution or much more time needs to be invested for analysis (counting and calculating) on the social network platforms directly.

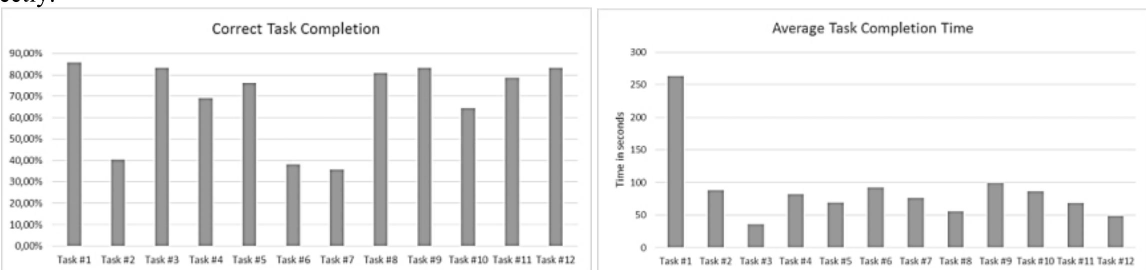

Fig. 6. Charts about the correct task completion (left) and the average consumed task completion time (right)

However, in this evaluation poor data has a significant impact on the results. Because this social media solution is very new only a data time frame of approximately three months is covered, where some aspects are not so easy to identify (e.g. task #7). But to cover as many real analysis tasks as possible of the target users, we tried to consider most of them. This is also necessary to provide comparability to other tools or in case of improved versions of our social media analysis software.

5. Conclusion

This paper described a best-practice procedure to develop and pilot novel software within large-scale projects and the example of our developed social media analysis solution. The social media solution is based on a modular architecture and is delicately designed for policy moulding in cities. Because of the different scope and expertise of stakeholders, goal definition and development is challenging. For this purpose we defined a Use Case Requirement Analysis Model to optimally support the identification and definition of requirements and to create an implementation timeline that considers all required features. Next to the UCR model, also innovative tools were introduced to collect empirical data, which gives clear and objective feedback as to if the development really meets the requirements and expectations, since the evaluation is based on real tasks. On this basis the developed social media solution could be successfully evaluated.

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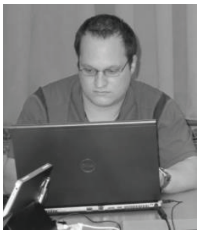

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