

# Designing a Tool to conduct Real-Time Delphi Studies in Research Projects

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**Abstract.** This paper shows the design of a prototype for conducting Real-Time-Delphi studies at time-critical events in research projects or workshops where experts are only available once. Real-Time-Delphi studies are used to get a consensus from experts about future developments of a specific topic. Application of the prototype in these contexts mitigates issues from classical Delphi Studies, as it allows them to be carried out in significantly shorter periods of time. The development of the tool went through several iterations with first applications and evaluations from a researcher's and a lecturer's perspective.

**Keywords:** Delphi method · Real-Time Delphi · Artifact · Design Science Research

## 1 Introduction

Future-oriented research keeps an eye on upcoming developments. Artifacts that are developed within the scope of research projects can thus be aligned with these developments. To ensure this, the so-called Delphi study is a possible research method that can be used in those projects. The Delphi method obtains consensus on forecasts of future trends and developments from a panel of experts. This requires experts to answer questions and/or assess these anonymously in several so-called rounds [1]. Anonymity prevents a group dynamic characterized by authority and dominance from developing and thus increases the quality of responses. After each round, the experts are provided with a summary of all answers given. Based on this summary, the experts can change their previous assessments. The fulfillment of a predefined termination criterion marks the end of a Delphi study. This method was developed in 1963 by the American RAND Corporation [2].

A major disadvantage of this method is that the conduction of several rounds requires a lot of time. Some Delphi studies last several months. Sometimes, however, experts are only available once in a certain time frame. Consequently, it is impossible to conduct a Delphi study. Moreover, after several months the consensus may already be outdated again. Real-Time Delphi (RTD) is a more efficient computer-aided and round-less way to conduct Delphi studies, which reduces several disadvantages of a classical

Delphi study such as the time needed to conduct it by allowing the experts' answers to be statistically analyzed and processed in “real-time” [3–5].

In this paper, we present a free and open-source tool to quickly configure and anonymously run RTD studies in time-critical meetings at research projects, workshops or other similar events.

## 2 Design of the artifact

This section provides details about the design process, features and configuration of our tool. The software tool was originally developed as part of the x.Navi-Framework and a public-funded research project [6]. It was used to conduct an RTD study to analyze future trends in competency management in companies [7]. The tool was developed in multiple iterations and applied in a research project and a university course. In iterations 2 and 3, an RTD study was conducted in which probands were questioned about a specific topic. After the study was conducted, requirements for the tool were determined. Table 1 shows the subjects, topics and resulting requirements for each iteration. Key features are highlighted in bold.

**Table 1.** Iterations and emerging requirements with key features

<b>Iteration</b>	<b>Emerging Requirements</b>
0	Initial Requirements: <b>Question-Types</b> in form of Text, Year-Forecast, Likert-Scale, <b>statistical overview</b> in form of boxplot
1	<b>Self-assessment</b> for a topic area QR-Codes
2	<b>Explanation</b> in form of help texts
3	Display the number of participating attendees, Information about min. and max. values at boxplot whiskers, Support of other data visualization types like histograms, Better explanation of the difference between a topic area and a thesis

*Iteration 0.* An initial meeting was held to define the basic requirements of a Real-Time-Delphi-Tool. To better understand what possible users would expect from the tool the requirements were defined with a group of futurologists during a research project.

*Iteration 1.* After the first implementation of our prototype, we provided the tool to futurologists and asked them to create a survey and give us feedback about the tool.

*Iteration 2.* The futurologists conducted a real-time Delphi survey with experts from the field of corporate competency management [6]. Afterwards, we presented the tool in a university course that teaches basics in research methods and created a survey for the students to answer. After the presentation and study execution, we asked the students for their feedback and further requirements for the tool and especially for the understanding of RTD studies.

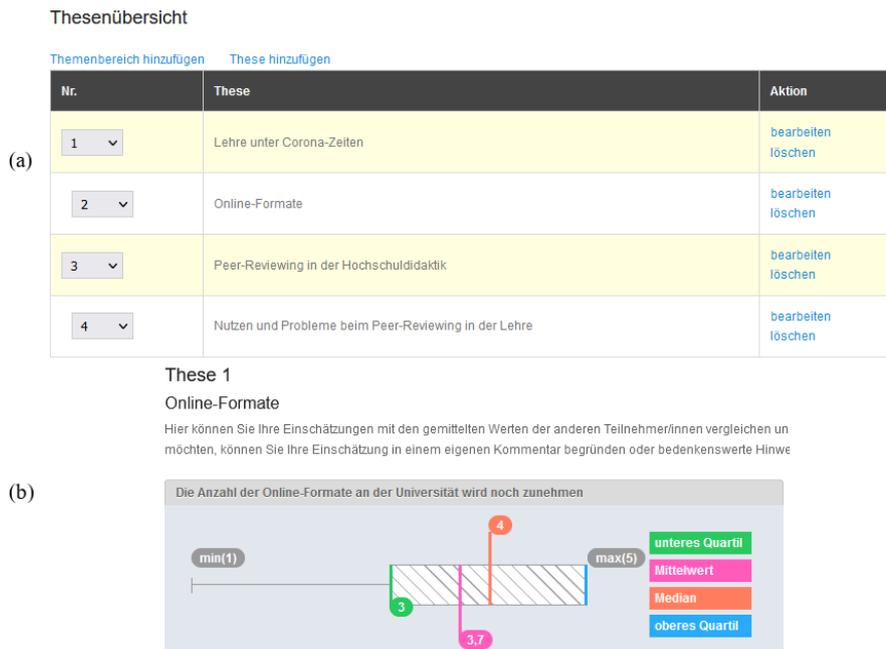
Iteration 3. After we implemented the requirements, we presented the tool at another event in a following semester (with new students) and, as before, we conducted a survey with the students and asked them for their feedback. In addition to the students from our course, a master thesis investigated the integration of embedded user assistance (EUA) [8], with 25 students from different universities in Germany, found it beneficial and identified further requirements. For example, in addition to the EUAs, the integration of a glossary as well as a contact form for questions to a teacher.

*Configuration.* To create an RTD study, creators must follow these steps: First, they define the title of the survey and a welcome and end message under the Configuration menu item and from which threshold value the statistically summarized answers visualized in a boxplot are displayed for the survey participants. Then, they create a topic area under the menu item Thesis overview. A topic has only one description and one answer option. This is used for the participants to assess their expertise in this topic area. Therefore, this data is not included in the statistical aggregation. If a topic area is defined, the creator can create theses that belong to this topic area. A thesis is a statement such as "Online formats will replace traditional meetings." For this thesis, the creator can then create different answer options with different types such as Likert scale, year statement, text. If a Likert scale is selected, the creators can choose between different sizes, e. g. 5 or 7. The creators can also select existing "answer sets" if they already exist or create new ones. For example, the answer set is labeled "The number of online formats will increase at universities." For this, the creator creates a five-digit Likert scale with the values "Do not agree at all" to "Agree completely". These values are saved as an answer set and can be used for further thesis statements or answer options.

When all topics and theses are created, the creators generate "Survey Tokens". Each of these survey tokens represents one participant. This allows us to guarantee complete anonymity within the system, as no personal data is stored in the RTD tool. Once the survey tokens have been created, they can be merged into a form letter using Word, Excel and Outlook, for example. This can be used to compose an invitation e-mail that can be sent to the participants. If the tool is to be used in a workshop where the participants are not distributed but sit centrally in a room, QR codes can also be generated from the survey tokens and these can be physically distributed to the participants.

*Process model.* An RTD study in our tool consists of the steps *self-assessment (1)*, *thesis response (2)*, *statistical aggregation of answers (3)*, *reassessment (4)* and *analysis (5)*. The QR code generated in the configuration step automatically takes participants to the starting page. Participants scan the QR code or enter the URL sent to them in their browser and are directed to the start of the survey. After reading the welcome message, they have to give a self-assessment about the first topic area (1). The next step is answering the theses that are assigned to this topic area (2). If the participant was not the first and is above the threshold defined by the creator, then, after answering all theses of a topic area, they see the aggregated answers in the form of a boxplot and, for the textual data, a listing (3). They then have the opportunity to change their answers again (4). After answering the theses, the participants can also view the results of the study and the possibly changed aggregated values after any period of time by simply using the previously used link again. The study creator can use serial mails to remind

and motivate participants to look at the results of the study and adjust their opinions if necessary. Steps 2 to 4 can be repeated several times, depending on how many topic areas have been configured. After survey completion, the creators can view the data or export it in CSV format and process it in another statistical analysis program such as SPSS (5). Since we have made sure that our tool complies with the Responsive Design guidelines, participants can complete the study with mobile devices adequately.



**Fig. 1.** Topic area/thesis configuration and aggregation of answers

Fig. 1(a) shows the configuration menu for topic areas (yellow) and theses at a top level. Fig. 1(b) shows a boxplot that is displayed after answering a topic area for each thesis, provided that the answers are given on a Likert scale.

### 3 Significance to research and practice

The implementation and application of our tool within workshops and research projects [7] enable us on the one hand to gain knowledge about the design of our tool and its application in research communities and on the other hand, the tool itself can be used by the scientific community to conduct RTD studies at time-critical events to get insights about possible future developments of their research objects.

Our implemented prototype can be used by everyone who wants to create a Delphi study with relatively small costs. The tool is open-source and can be found with the source code and an instruction page here <sup>1</sup>.

Moreover, our tool enables researchers or practitioners to learn about the research methodology Delphi and especially Real-Time Delphi by experiencing how a study is designed and conducted. Due to the real-time factor, this can be done directly, for example, in a workshop to conduct non-biased opinions about one or more topics and is therefore easy to integrate for the workshop moderators. The results, being immediately available, can then be used afterwards for further discussions or other workshop formats and are not outdated, because all these were provided to the participants in a short time frame (in contrast to a Delphi study that can last several months).

Another advantage of the tool is the focus on purely conducting Delphi studies. Other survey tools that allow Delphi studies to be conducted, often provide a plethora of other features and methods to be executed. Our tool allows a more efficient focus on conducting the study itself.

## 4 Evaluation of the artifact

As a first step, to evaluate whether our prototype meets the requirements of a practical real-time Delphi tool, we asked futurologists and students before each design iteration, as shown in section 2, whether they thought there were any missing features or other suggestions for improvement. This led to emerging features we incorporated into the RTD tool. In a second evaluation step, it was shown to a research assistant after the third iteration who had the task to create a Real-time Delphi survey for a lecture. We asked him to rate different aspects of our tool based on an evaluation system from Aengenheyster et al. [9], e. g. the difficulty of launching the survey, real-time-factor or accessibility, which indicated that some aspects already were adequately satisfied.

While retaining these two steps for further design iterations in the future and alternating design and evaluation, we plan to conduct a full ex-post evaluation study under field conditions in different research projects with researchers as well as with students in one of our university courses that teaches fundamentals in research methods. Building on the findings, we plan further evaluation cycles with SMEs to explore the general application of our tool. In these studies, our tool will be evaluated from two different perspectives: On the one hand, we ask the expert panel that has to participate in the RTD study and, on the other hand, the creators of the RTD study who have to create the theses/questions and configure the tool. For this purpose, we are currently developing a survey based on the evaluation framework from Gemino and Wand [10]. We will ask novices as well as experts in the field of RTD regarding the effectivity (i. e. dimensions from Aengenheyster et al. [9], as stated above) and we will measure the efficiency (i. e. time to configure and conduct an RTD study in a strict time frame to measure ease of use) of the artifact. Asking about the effectivity will particularly focus on complete-

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<sup>1</sup> [https://github.com/MethodJules/real\\_time\\_delphi](https://github.com/MethodJules/real_time_delphi)

ness (i. e. asking for missing features) and interpretability/understandability of the statistical summaries that are shown to the users after completing a topic area as well as other features. Ultimately, this enables us to rate the usefulness of our artifact regarding the application at time-sensitive events like meetings at research projects, lectures or events that take place only once.

Additionally, we plan to introduce more support for novice RTD study creators, e. g. helper widgets explaining the core concepts of RTD studies and providing help in posing adequate theses and questions for RTD studies.

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