Delphi Method: A comparative analysis of existing Web-Delphi platforms

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Abstract

In the last 20 years, there has been a growth of web platforms designed exclusively to implement the Delphi Method. Companies have developed these platforms benefiting from the evolution around web surveys, whose technological features helped overcome limitations inherent to the Delphi method's implementation. The Web-Delphi platforms available in the market differ among them regarding the features available for users, influencing how a Delphi process is implemented. Given the lack of tools to compare these platforms, the process of choosing one to implement a Delphi study becomes complex. Thus, this dissertation aims to perform a comparative analysis on the operation of these platforms and explore how their features can improve the implementation of the method. To meet this objective, the WDP Features Framework was created to allow for a comparative analysis between the different platforms available. The Framework is divided into different areas of concern, and each one has a list of features. Based on the Framework, a multi-criteria decision analysis model was also proposed to evaluate these platforms and help users choose an adequate platform. It was possible to understand which features were considered more important by the different companies and which are less used. Furthermore, it was possible to observe the development of each platform in each area of concern, considering the number of additional features present in them. With this work, it is now possible to provide a future user with objective knowledge of how these platforms work and thus facilitate a future decision to choose one.

Keywords: Delphi Method; Web-Delphi; Web-Delphi Platforms; MACBETH; MCDA; Hierarchical Additive Model.

1. Introduction

Described as a technique created to "obtain the most reliable opinion consensus of a group of experts by subjecting them to a series of questionnaires in-depth interspersed with controlled opinion feedback" [8, p.7], Delphi Method is a social communication technique that helps structure group communication and at the same time helps inhibit problems associated with traditional group decision-making processes. Over the years, several studies and variants of the original method have been developed [32] to increase the efficiency of its survey procedure and to overcome its weaknesses and defects, such as participants panel instability and time consumption [17]. It started as a paper-based method but given the digital revolution it was possible to start thinking on a new perspective of the Delphi method: its implementation in digital format. Only traditional mail had been used to tackle participants' distance, but in 1997, the first online Delphi study was conducted by E-mail and was successfully done [4]. After that, survey platforms such as Google Forms (www.docs.google.com/forms), and SurveyMonkey (www.surveymonkey.com), started to emerge and be used, but none of them were optimized for implementing Delphi processes. Over the last 20 years, several online platforms with specific web-surveys for Delphi have been designed and created to mitigate its limitations and maximize its advantages, by making the method more flexible and accessible without losing its original essence and validity. For example, Welphi (www.welphi.com) and Mesydel (www.mesydel.com) are two platforms that were specifically designed to implement Delphi processes. At the same time, the use of these platforms not only tackles participants distance, but also turned to be quicker and cheaper than classic paper and pencil processes, thus more efficient, economic, and sustainable [11]. From now on, I will call these software-based platforms with specific web-surveys for Delphi as Web-Delphi platforms (WDP).

2. Problem's Definition

Currently, there are several WDP available online, which in turn raises the question: "Which one is more suitable to implement a Delphi process?". Although they were all designed with the same purpose, we cannot ignore the differences between them. Such differences can influence the way Delphi is implemented and lead to different scenarios, such as lower dropout rates, simpler and more intuitive processes, better protection of user data, and other consequences. After a literature review focused on this subject, it was concluded that there is a significant lack of articles that address how WDPs work and what their advantages are in implementing Delphi processes. To address this issue, the present dissertation proposes and applies a methodological framework capable of analysing the presence of features that facilitate and optimize the implementation of the Delphi Method on these platforms. In this way, it will then be possible to perform a comparative analysis between the different WDPs available in a clear and objective manner. However, the application of this framework is not enough to decide which platform is better and which criteria are more important to consider when choosing a WDP. Therefore, the respective framework will also be used to propose the construction of a multicriteria model followed by the MACBETH approach, which is able to evaluate and score the performance of the respective WDPs.

3. Literature Review

3.1. Delphi Method

The technique was originally created at RAND Corporation at Santa Mónica to be a forecasting tool for dealing with future situations, through the statistical analysis of individual opinions from a vast number of participants [27]. Originally, the main objective of the Delphi method was to reach a reliable consensus among the opinions of a group. This consensus is worked out and achieved through individual and repeated questioning of a series of questionnaires interspersed over a certain period where the questions are all centred around a problem and are answered without direct confrontation between the participants [8]. However, Linstone and Turoff (1975, p.3) stated that "Delphi may be characterized as a method for structuring a group communication process so that the process is effective in allowing a group of individuals, as a whole, to deal with a complex problem". Delphi method was no longer seen as a method in which a consensus had to be reached but rather as a method that helped to structure group communication. Delphi processes can bring clarity to an issue, increase stakeholder's understanding of the respective views of other participants, and explore different opinions [10].

Anonymity, ***Iteration*** *with* ***Controlled Feedback***, and ***Statistical Analysis of Group Response*** are the reason why Delphi is so worthy and distinct among other face-to-face decision-making methods such as Focus Group Technique and the Nominal Group Technique [9,26]**.** The participation is done anonymously among the members, which allows free expression and avoids the possibility of one panel member being influenced by another. Decisions are evaluated by the content of the response and not by the reputation of the member who proposed it [34]. Members can change their mind in the following rounds without anyone knowing they have done so. Without anonymity, members might hesitate to change their opinion in view of the responses given in the previous round, wanting to defend a stand once taken [30]. Iteration gives panel members an opportunity to rethink their perspective towards the progress of group work [34]. Throughout the iterations, experts are expected to become more perceptive in expressing their opinion [23]. Feedback control ensures that the group only focuses on the original goal and does not get lost in the personal goals of panel members [30]. Only the information inherent to the problem is selected by the moderator, thus contributing to better efficiency of the process and noise reduction [23]. Group responses are presented in statistics. All the opinions of the group are included in the forecast, unlike most conventional forecast methods that only present the majority opinion [30].

3.1.1. Delphi Weaknesses, Limitations and Challenges

The Delphi method is applied in several areas and should be noted that there may be problems with its application depending on the area being studied. The following limitations are inherent to the Delphi method in general and not in particular cases.

Starting with the inherent weaknesses and limitations of the Delphi Method:

Participants panel instability can compromise the effectiveness of the process, making it difficult to attain convergence of opinions [16]. Possible interviews, design, distribution, collection, and analysis of questionnaires are activities that are typically *time-consuming***.** Too much time between rounds can be harmful because it calls for participants to give up [9,12]. *Poor definition of consensus* that leads to many different interpretations of consensus in Delphi studies [3,19]. Consensus should always be defined and well explained to all participants before starting the process [24]. *Consensus through an undue average* where median as a measure of the group opinion and the quartile as a measure of disagreement between opinions cannot be taken as absolute truths. Opinions that are far from the majority opinion are often lost throughout the process, however, many of them may be correct if they are properly justified to the panel. It is, therefore, necessary to insist on the justifications of minority opinions [16].

The following points relate to the challenges a moderator faces in implementing Delphi processes:

Misinterpretation of results due to subjective opinion in the responses given by panel members [18] and *ambiguous and vague questions* can lead to different interpretations by participants [5].

3.1.2. Web-Delphi Platforms

The creation of WDP and its use allow organizing, controlling, and facilitating communications between the panel members and the moderator [12]. The use of online surveys in WDP to conduct a Delphi study not only minimizes the time needed to conduct it but also maximizes its participation. The ease of connection through the Internet makes it much easier to select potential participants on a global level and consequently the communication between the moderator and the participant. The delivery of surveys, survey deadline reminders, data collection, and analysis have become much easier with the introduction of Internet-based technology. Time is then optimized and there is a drastic decrease in recruitment costs [11,21].

The following points are adapted from Holloway (2012) and describe the advantages inherent in using a WDP:

Geographical and temporal flexibility since participants with access to the internet can be anywhere in the world and participate in the study [33,25]. There is no face-to-face contact between participants so *anonymity within the group is promoted* [33]. *Speed in processing and collecting data* since data is automatically collected and processed [25]. *More cost-effective*, since participants do not need to travel and be physically present at interviews and survey rounds [22,6]. *Efficient recruitment* without limiting the choice of participants due to their geographical location [22]. *Promotes more reflective responses* since participants have more time to think and work on what they will answer as they can access the question more easily and the answer is sent immediately once they submit it [15]. Platforms with *multimedia capabilities* that allow the insertion of multimedia content such as explanatory videos and other informative content can be very helpful to engage participants and promote a better explanation of the process [20]. *Embedded data along with adaptive questions* to the person who is answering them. The process becomes easier in the user's view, increases the participants' response rate, and decreases the time taken to finish the surveys [20].

Although the WDP has brought several advantages to the Delphi Method, the platforms are also subject to shortcomings:

A recent study from Daikeler et al. (2019) showed that web-surveys, in general, have *lower response rates* than traditional methods. This can result from different causes such as users feeling that web questionnaires are less mandatory, errors in filling and submitting the questionnaire, lack of support and understanding of the platform, and other causes [7]. Other earlier researchers also support this idea [13,6,3], however, people are becoming even more familiar with the use of the web and therefore this scenario is constantly evolving. *Participants and even researchers may need support* if the platform is complex and not very self-explanatory. The participants especially can have difficulties during the process, leading to time-consuming situations or even the dropout of the process [13,21]. *Confidentiality and privacy can be threatened* due to possible hacker attacks due to lack of data protection [6]. Nowadays it is quite unusual, but there may be participants who *do not have access to the internet and/or electronic devices* to answer the questionnaire [25]. Progress saving issues due to computer malfunctions and internet failures can occur during the process [35].

The evolution of features has made it possible to combat these drawbacks, and therefore, it is important to register which are these features and if they are currently present in today's WDPs. Therefore, all these insights obtained in the literature review will serve as one of the bases for the construction of the framework which allows recording which of these features that optimize the implementation of Delphi processes in WDPs are present in these platforms.

Principles for construction Web-Surveys

Additionally, some principles that should be considered in the general implementation of web-surveys were also studied to consolidate the insights gathered previously [37]:

- Provide an appealing and motivational design on the welcome screen of the questionnaire, with simple instructions to ensure the engagement of participants.
- The first question should be fully visible and easily perceived. The first question is the participant's first impression and therefore will define whether the survey is complicated or easy to complete.
- The presentation and format of the questions should be similar to those used in paper questionnaires.
- Provide instructions for all necessary computer actions in a clear and succinct way (Button instructions, explanatory examples, and others).
- The filing instructions should be accompanied by the question and not in a separate section outside the survey.
- The questions should allow participants to skip questions to answer the subsequent ones. Participants should also have the possibility to go back and change the answers.
- The questionnaires should be sufficiently perceptive to ensure that participants see all questions and know which ones are unanswered.
- Provide graphic symbols for monitoring the progress of the participants and to be able to see at what stage of the questionnaire they are.

Although these principles were developed 20 years ago, they are highly significant and applied nowadays and therefore these principles should be considered in the WDPs.

3.2. Multi-criteria Decision Analysis (MCDA)

A Multi-Criteria Model is also going to be proposed, and as such, it is also necessary to review some concepts and content in this area. Multi-criteria Decision Analysis (MCDA) are methods that are used to support decision-makers in decision-making processes, by analysing multiple criteria and subjective opinion of each decision-maker involved in the process [2]. Therefore, in addition to offering better-supported techniques based on decision matrices to compare project alternatives, MCDA also has the advantage of incorporating project stakeholders' views and opinions into the ranking alternatives [28]. MCDA models usually involve three steps [2]:

Problem Structuring – Identify goals, stakeholders, values, alternatives, uncertainties, and constraints.

Model Building – Specifying alternatives, criteria definition, and values elicitation.

Testing and Development of Action Plans – Performance of sensitivity and robustness analysis and selection of the more attractive alternative.

3.2.1. MACBETH Approach

MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique) is described as a "multicriteria decision analysis approach that requires only qualitative judgments about differences of value to help an individual or a group quantify the relative attractiveness of options" [14, p.3]. In contrast to other multi-criteria methods, the generation of numerical scores for the alternatives in each criterion and the weighting of the criteria by MACBETH is done through the collection of qualitative judgments about the difference of attractiveness between two elements at a time (Bana, Meza & Oliveira, 2013). The method follows the principle of converting qualitative information into quantitative information and this conversion is done using a semantic scale with different verbal levels of attractiveness (null, very weak, weak, moderate, strong, very strong, extreme). To facilitate the implementation of the MACBETH method, Carlos Bana e Costa, Jean-Marie de Corte, and Jean-Claude Vansnick designed a software called M-MACBETH (available at www.mmacbeth.com). This software allows to generate scales, generate graphs and figures to support the analysis, detect inconsistencies in the judgments entered in the program, and allows to perform sensitivity and robustness analysis regarding the models created. MACBETH also has the advantage of being a method that uses qualitative rather than quantitative judgments, which is a plus for decision makers with poor numerical skills.

4. Methodology

This methodology is mainly focused on two different phases:

− Construction and application of a framework capable of performing a comparative analysis on the different WDPs.

− Propose a multi-criteria model using the previous framework as its basis that can evaluate the WDPs.

4.1. WDP Features Framework

The WDP Features Framework was created to develop the comparative analysis between the different WDPs. The framework is based on the evaluation of the presence of

features in the respective platforms. It allows the analysis to be simple and objective and easily understood.

Semi-structured Interviews

To consolidate the knowledge gathered from the literature review, interviews were also conducted with people who have implemented Delphi processes in WDPs as moderators, and with people who have participated in Web-Delphi processes as participants. The semi-structured interview technique was used to conduct the interviews. It consists of the realization of pre-defined questions which in turn are adapted according to the answers of the interviewee and has the advantage of bringing a more real and detailed perception of the interviewee regarding the subject (McIntosh & Morse, 2015). A total of four Interviews were handled in two different approaches: two from a participant perspective and two from a moderator perspective. The data documentation of the interviews was based on three main steps from Flick (2019): *Recording Data*, Editing Data, and *Constructing a "New Reality"*.

Search Protocol

To apply the Framework is necessary to search and identify which WDPs are currently available for evaluation. For this reason, a search protocol has been created with the aim of finding all currently available WDPs. After defining the following search question: "Which Delphi online platforms are currently available?", a group of concepts and keywords were defined from this question. This group originated the string: ["Delphi" OR "Delphi Method" OR "Delphi Process" OR "Delphi Technique" OR "Delphi Survey" AND "Online" OR "Internet*" OR "Web*" OR "Computer*" OR "Network*" AND "Platform" OR "Program" OR "System" OR "Tool" OR "Software"] that was used in the different search engines (Google, Google Scholar, Web Science and Scopus). Finally, the following rejection criterion was identified to select the platforms found: The platform was exclusively designed to implement Delphi processes; The platform is currently available and accessible to the public; The platform is able to fulfil all the key features of the Delphi method during a Delphi process.

Licenses Requests

It was necessary to apply for an access license on the platforms that were not free and on those that did not have a free trial. For platforms that did not meet these two standards, it was requested user guides, video tutorials, video calls, and e-mails were exchanged with members of the platforms' team to clarify doubts about the functionalities of the platforms. The platforms on which it was not possible to apply the previous analysis methods have been recorded and proposed for future work.

Framework Construction

The framework was built (Table 1) and first divided on the key criteria of the Delphi Method: *Anonymity*, *Iteration*, *Controlled Feedback*, and *Statistical Aggregation*. Thus, based on the findings of the interviews and the literature review, a set of features were created and divided among those four areas of concern and other two more areas, making a total of six. The remaining areas are *Implementation Features* which encompasses features concerning the construction of the questionnaires, and *Participant User-Friendliness* which covers features relating to the ease of handling of the platform by the participant.

4.3. Multi-criteria Decision Analysis (MACBETH) Proposal

The following stages were adapted from Bana e Costa, Carnero & Oliveira (2012) to propose the MCDA:

Structuring – Areas of concern and criteria definition, and construction of descriptors of performance. It is recommended to use the areas of concern defined in the WDP Features Framework as the areas of concern in this model: *Anonymity*, *Iteration*, *Controlled Feedback*, *Statistical Aggregation*, *Implementation Features*, and *Participant User-Friendliness*. The criteria and their descriptors can also be defined based on the Features represented in the Framework.

Evaluation – Construction of value functions that allow transforming performance into value and calculation of Criteria and Areas weights.

Testing – It is necessary to understand if the model is requisite. When the model's form and content are sufficient to provide satisfactorily uncontroversial answers to the problems that spurred its development, the model is considered "requisite" [1]. Sensitivity and Robustness analysis are performed to develop recommendations for the problem at hand.

Model Outputs – We can evaluate each WDP performance, partial scores, and overall scores. To calculate the *partial value score* of each WDP in a specific area of concern and the *overall score* of each WDP, we can use the *simple additive model* (1) and the *hierarchical additive value model* (2)**,** respectively [36]:

$$v_h(x_{1_h},\dots,x_{j_h},\dots,x_{n_h}) = \sum_{i=1}^{n} k_{j_h} v_{j_h}(x_{j_h}) \; with \begin{cases} v_{j_h}(good_{j_h}) = 100 \\ v_{j_h}(neutral_{j_h}) = 0 \end{cases} \quad (1)$$

$$v(WDP) = \sum_h \left(k_h \sum_{j_h} k_{j_h} v_{j_h}(x_{j_h})\right) \quad (2) \; with \quad \sum_{j_h} k_{j_h} = 1 \text{ and } k_{j_h} > 0$$

- $h = 1,\dots,m$ designates the areas of concern;
- $j_h = 1_h,\dots,n_h$ designates the criteria of area h;
- X_{j_h} corresponds to the descriptor of performances of criterion j_h and
- $v_{j_h}: X_{j_h} \to \mathbb{R}\ ou\ \Re$ designates the respective value scale;
- x_{j_h} designates the performance of alternative x on criterion j_h;
- $v_{j_h}(x_{j_h})$ designates the partial value score of the alternative x on the criterion j_h;
- $(x_{1_h},\dots,x_{j_h},\dots,x_{n_h})$ designates the performance of alternative x;
- $(v_{1_h}(x_{1_h}),\dots,v_{j_h}(x_{j_h}),\dots,v_{n_h}(x_{n_h}))$ designates the value profiles of alternative x;
- $good_{j_h}$ and $neutral_{j_h}$ are the "good" and the "neutral reference levels of performance on criterion j_h;
- k_{j_h}designates the weight of criterion j_h and k_h designates the weight of area h.

5. Results

The following Table 1 represents the WDP Features Framework:

Table 1 - WDP Features Framework

Features	
	Anonymity
Anonymity moderator	Participants' anonymity can be ensured between the participants and the moderator
Anonymity participants	Participants' anonymity is ensured within the participants
	Iteration
Process monitoring*	Platform is able to track each participant responses (e.g., grouping who did not respond, who did respond and who is responding at that moment)
Round replication	Moderator can replicate the previous round to create a new one (instead of creating another from scratch)
Unlimited rounds	Platform do not have limit of rounds per Web-delphi process (it is unlimited)
E-mail tracking	The moderator receives delivery reports of the e-mails he sends
Built-in E-mail system*	Platform has a built-in e-mail system
Personalized e-mails*	E-mails can be automatically personalized to each participant (e.g., "Dear 'Participant Name' ")
Reminders*	Platform has a built-in reminders option (automated specifically for reminders)
Link	Questionnaire can be shared by link (generated by the platform)
QR code	Questionnaire can be shared by QR code generated by the platform
Apps Share	Questionnaires can be shared through other apps via a share button from the platform that was specifically created for that purpose (Facebook, Twitter, LinkedIn, etc.)
	Controlled feedback
Quantitative data	Platform enables quantitative data collection
Qualitative data	Platform enables qualitative data collection
Qualitative data editing	Platform enables the editing of qualitative data for feedback control purposes (e.g., edit comments)
Visual presentation*	Statistical group response data can be presented in the form of charts in the platform itself
Real-time Feedback	Feedback can be delivered in real-time
Feedback along with the questions*	Platform has an integrated feature that allows the feedback to be displayed along with each question
Date Filter	Time interval for analysis can be set by choosing a start date and an end date. The collected data is only from that period even if the round has a longer duration
Individual respondents	Particular individual answers can be selected for individual analysis (Not only particular groups of stakeholders but also particular individual singular responses)
Grouping users	Platform allows the aggrupation of users in different groups of stakeholders (Allowing analysis per group of stakeholders)
Comment boxes*	Platform allows to add boxes along with each question for comments with multiline
Previous answers*	Answers from the previous round are already typed in the subsequent round
	Statistical Aggregation
Data generation*	Statistical group response data is automatically generated
Data analysis tool	Platform has an integrated feature that allows advanced data analysis besides the generation of statistical group response data (e.g., consensus measurement, stability of responses)
Data exportation*	Raw data can be exported to external statistical analysis tools
	Implementation features
Predefined themes*	Platform have predefined themes that help you to create questionnaires quickly
Page replication	Users can replicate a page to create a new equal one
Question replication	Users can replicate a question to create a new equal one
Auto-saving construction*	In the questionnaire construction the progress is automatically saved whenever there are any changes
Same page*	Different questions type and chapters of the questionnaire can be put in a same page
Page break*	Questions and chapters of the questionnaire can be separated on different pages
Welcome/End pages*	Platform allows to create a personalized welcome/end page in the questionnaire (e.g., instructions page)
Multiple languages*	Allows the creation of questionnaires with multiple languages (the respondents can choose their preferred language)
Questionnaire customization*	Allows to customize the questionnaire freely (e.g., colors, font, and font size)
Attach pictures*	Each page and/or questions can be attached to a picture or logo
Type of questions	Platform offers a wide range of type of questions (dropdowns, radio buttons, response scales, text boxes etc.)
Input validation	Users can set which type of input is valid for an open question (e.g., email/date/time/month/week/color/phone)
Set required fields	Particular questions can be set as required fields
Set other choices	Participants can have the ability to type a different answer from the ones available (in multiple choice for example)
Learning*	Platform offers a learning and support system with different learning alternatives (e.g., video tutorials, examples, demonstrations, user guides, etc.)
Questionnaire preview	The platform has a feature that allows you to preview the created questionnaire pages
Pretest*	Platform offers a pretest function
Import a list of participants	Platform allows the importation of a list of participants (csv files)
	Participant user-friendliness
Registration*	Participants' registration is mandatory
Registration/log in easiness*	The registration process is simple and non-exhaustive. Users only need to submit their e-mail and a password as mandatory fields
Instructions along with the questions*	Questions can have instructions along with each question
Progress bar/indicator*	Questionnaires have a progress bar/indicator where the participants can see at what stage of the questionnaire they are in
Auto-saving answers*	The platform automatically auto-saves participants' progress during the round
Device adaptation*	Site is adapted for each participant depending on the device they are using
Live Chat*	Live chat available to clarify doubts and solve possible issues in real-time (with human intervention)
Chat bot	Live chat available to clarify doubts and solve possible issues in real-time (without human intervention)
GDPR	Platform complies with EU General Data Protection Regulation
Submission warnings*	Platform can give warnings regarding how many questions that are left to be answer and what percentage of the questionnaire the participant is currently on

Table 2 - WDP Features Framework application in each selected WDP

Features	Welphi	eDelphi	Mesydel	Calibrum	D.M.	HalnyX
Anonymity						
Anonymity moderator	Yes	Yes	Yes	Yes	Yes	Yes
Anonymity participants	Yes	Yes	Yes	Yes	Yes	Yes
Iteration						
Process monitoring*	Yes	Yes	Yes	Yes	Yes	Yes
Round replication	Yes	Yes	Yes	Yes	Yes	N/A
Unlimited rounds	Yes	Yes	Yes	Yes	No	N/A
E-mail tracking	No	No	Yes	No	Yes	No(4)
Built-in E-mail system*	Yes	Yes	Yes	Yes	Yes	No(4)
Personalized e-mails*	Yes	No	Yes	Yes	Yes	No(4)
Reminders*	Yes	No	Yes	Yes	No	No(4)
Link	Yes	Yes	Yes	Yes	Yes	Yes
QR code	No	Yes	Yes	No	No	No
Apps Share	No	No	No	No	No	Yes
Controlled feedback						
Quantitative data	Yes	Yes	Yes	Yes	Yes	Yes
Qualitative data	Yes	Yes	Yes	Yes	Yes	Yes
Qualitative data editing	Yes	Yes	Yes	Yes	Yes	Yes
Visual presentation*	Yes	Yes	Yes	Yes	Yes	Yes
Real-time Feedback	No	Yes	No	Yes	No	Yes
Feedback along with the questions*	Yes	Yes	No	Yes	Yes	Yes
Date Filter	No	No	Yes	No	No	No
Individual respondents	Yes	No	Yes	No	Yes	Yes
Grouping users	Yes	Yes	Yes	Yes	Yes	Yes
Comment boxes*	Yes	Yes	Yes	Yes	Yes	Yes
Previous answers*	Yes	Yes	No	Yes	Yes	Yes
Statistical Aggregation						
Data generation*	Yes	Yes	Yes	Yes	Yes	Yes
Data analysis tool	No	No	Yes	Yes	No	No
Data exportation*	Yes	Yes	Yes	Yes	Yes	No
Implementation features						
Predefined themes*	No	No	No	No	No	No
Page replication	No	Yes	Yes	Yes	No	No
Question replication	No	Yes	No	Yes	No	Yes
Auto-saving construction*	Yes	Yes	Yes	Yes	No	No
Same page*	No	No	Yes	Yes	No	Yes
Page break*	Yes	Yes	Yes	Yes	Yes	No
Welcome/End pages*	Yes	Yes	Yes	Yes	Yes	Yes
Multiple languages*	No	No	Yes	Yes	Yes	No
Questionnaire customization*	No	Yes	Yes	Yes	No	Yes
Attach pictures*	No	Yes	Yes	Yes	Yes	Yes
Type of questions	Yes	Yes	Yes	Yes	No (6)	Yes
Input validation	No	No	No	Yes	Yes	Yes
Set required fields	Yes (1)	No	Yes	Yes	Yes	Yes
Set other choices	Yes	No	Yes	Yes	No	Yes
Learning*	Yes	Yes	Yes	Yes	Yes	Yes
Questionnaire preview	Yes	No	Yes	Yes	Yes	Yes
Pretest*	No	No	Yes	Yes	Yes	No
Import a list of participants	Yes	Yes	Yes	Yes	No	No
Participant user-friendliness						
Registration*	Yes	Yes	Yes	Yes	Yes	Yes
Registration/log in easiness*	Yes	Yes	Yes	Yes	Yes	Yes
Instructions along with the questions*	Yes	Yes	Yes	Yes	Yes	Yes
Progress bar/indicator*	Yes	Yes	Yes	Yes	Yes	Yes
Auto-saving answers*	Yes	No (1)	Yes	No (2)	No (1)	No (1)
Device adaptation*	No	No	Yes	Yes	No	Yes
Live Chat*	No	No	No	No	No	No
Chat bot	Yes	No	No	No	No	No
GDPR	Yes	Yes	Yes	Yes	Yes	No (5)
Submission warnings*	No	No	Yes	No (3)	Yes	Yes

Table 2 represents the application of the WDP Features Framework to the respective WDPs selected by the search protocol. A total of 13 platforms were found, but however, only six were eligible for evaluation. Refusal of access licenses, insufficient information, and platforms that are not currently available for use were the reasons for the remaining platforms not being evaluated. The following tables provide an overview of each WDP that was applied in this study:

Table 3 - Welphi Platform Overview

Welphi	
Released date	2018
Languages	Portuguese, English
Country of origin	Portugal
Developed by	Decision Eyes (company)
Price	Welphi Basic €40/month; Welphi Plus €100/month; Welphi Premium €500/month
Free trial	Free 14-day trial
Site URL	https://www.welphi.com/

Table 4 - eDelphi Platform Overview

eDelphi	
Released date	1998
Languages	Finnish, English
Country of origin	Finland
Developed by	Hannu Linturi, Osmo Kuusi, Jari Kaivo-oja, open-source community
Price	Basic €0; Plus €90/3months, €150/6months, €240/12months; Premium €180/3months, €300/6months, €480/12months; Premium ORG €450/3months, €750/6months and €1200/12months
Free trial	Free access to eDelphi Basic Version
Site URL	http://www.edelphi.org/

Table 5 - Mesydel Platform Overview

Mesydel	
Released date	2010
Languages	French, English
Country of origin	France
Developed by	University of Liege
Price	3 to 30€ per process
Free trial	No
Site URL	https://mesydel.com/

Table 6 - Delphi Manager Platform Overview

Delphi Manager (D.M.)	
Released date	2012
Languages	English
Country of origin	England
Developed by	COMET
Price for user	€200/process
Free trial	No
Site URL	https://www.comet-initiative.org/delphimanager/

Table 7 - Surveylet by Calibrum Platform Overview

Surveylet by Calibrum	
Released date	2000
Languages	All languages
Country of origin	United States of America
Developed by	Calibrum (originally developed by Jozsef Nagy, founder of Calibrum)
Price	Multi-level pricing starting from $12/response to $2/response depending on the number of responses you purchase; a "response" is a panelist's response to the entire survey
Free trial	No
Site URL	https://calibrum.com/

Table 8 - HalnyX Platform Overview

HalnyX	
Released date	2015
Languages	Polish, English
Country of origin	Poland
Developed by	Polish Society for Futures Studies, and later improved by 4CF Strategic Foresight
Price	
Free trial	No
Site URL	https://4cf.pl/en/

As we can see in the WDP Features Framework some fields represent exceptions in each WDP. To see what each field implies, the following Table 3 was created to help the reader understand the results:

Table 9 - WDP Features Framework Reading Support

Yes	The feature is present in the WDP of the respective column.
No	The feature is not present in the WDP of the respective column.
(Feature)*	Features that were valued by the interviewees according to the interviews' conclusions
N/A	This feature is not possible to evaluate on this WDP, because this is a platform that only implements one round Real-Time Delphi processes.
Yes(1)	Only a few question types can have this characteristic
No(1)	When you click 'next page' the platform saves the answers from the previous page but does not save the answers from the page you were responding.
No(2)	Only for radio buttons responses. The remaining ones operate according to No(1)
No(3)	No direct warning, but missed questions and current progress is available for panelists to view at any time
No(4)	Facilitator do not have the power to send e-mails through the platform manually, but the platform sends automatic e-mails to the participants
No (5)	The platform does not comply with GDPR, but the facilitator can do this by himself (using a checkbox to comply with GDPR before the survey starts for example)
No(6)	The platform only has one type of answer available to use on the survey, but it is possible to add free text buttons, dropdowns, checkboxes, radio buttons and date buttons to the registration form

Table 10 describes the percentage of Features that each WDP employs in each area of concern. This way we can get an

overview of which areas are more invested in by each platform.

Table 10 – Percentage of features that each WDP employs in each area of concern

Welphi	eDelphi	Mesydel	Calibrum	D.M.	HalnyX
Anonymity (A)					
100%	100%	100%	100%	100%	100%
Iteration (I)					
70%	60%	90%	70%	60%	30%
Controlled Feedback (CF)					
82%	82%	73%	82%	82%	91%
Statistical Aggregation (SA)					
67%	67%	100%	100%	67%	33%
Implementation Features (IF)					
50%	56%	83%	94%	50%	61%
Participant User-Friendliness (PUF)					
70%	50%	80%	60%	60%	60%

Table 11 represents the variability of the results from Table 10. This Table allows us to study the heterogeneity of the sample to enrich the description of the results obtained.

Table 11 - Variability of results from Table 10

	A	I	CF	SA	IF	PUF
Min	1,00	0,30	0,73	0,30	0,50	0,50
Max	1,00	0,90	0,91	1,00	0,94	0,80
Range	0	0,60	0,18	0,70	0,44	0,30
Mean	1	0,63	0,82	0,72	0,66	0,63
Variance	0	0,03	0,003	0,05	0,03	0,009
Standard Deviation	0	0,18	0,05	0,23	0,17	0,09
Coefficient of variation	0	28%	6%	32%	26%	15%

Starting with **Anonymity**, all platforms meet all the features, so the average in this area is 1. This result was expected because this is an area that presents only two features, and one is mandatory in the practice of the Delphi method (the anonymity among participants). It is then the most developed area, but nevertheless, it is the area that represents the least number of features.

As for **Iteration**, the amplitude of this area is the second highest (0.60) in the table, meaning that there is a large difference in the number of features between the platform that fulfils more features and the platform that fulfils fewer features in this area. The average is also the lowest in the table (0.63) and the coefficient of variation is the second highest in the table (28%), meaning that it is the second area where the platforms differ most in terms of feature fulfilment and should be developed. It is recommended that the HalnyX platform further develop and invest in the features in this area since it comprises only 30% of the features in this area.

Controlled Feedback has the second highest average (0.82). The coefficient of variation is only 6%, which translates an area that is well developed and present in the platforms in general. The minimum value of this area is 0.73 (73%) and represents the second highest Min value in the table.

Regarding **Statistical Aggregation**, the average is high (0.72), but nevertheless, we are talking about an area of concern that groups only three features. The coefficient of variation is the highest (32%), being thus an area that should be further developed and present across some platforms, namely HalnyX that meets only 33% of the features related to this area. Once again, it is recommended that the HalnyX platform further develop and invest in the features in this area. Analysing the results concerning the Implementation Features area, we conclude that it is an area with a coefficient of variance (26%), very close to the coefficient of variance of the Iteration area (28%), but with a smaller amplitude and a higher average (0.66). Thus, it is an area a little more explored than Iteration but that also requires greater development and investment of features by some WDPs.

Finally, **Participant User-Friendliness** is an area that just like the iteration presents the lowest average (0.63) but on the other hand has a much lower coefficient of variation (15%), which means that although the features of this area are (on average) less present in the platforms, the platforms are more homogeneous in terms of features presenting similar degrees of development.

By analysing the data in Table 2 it is possible to see which Features are least present in each area of concern in these WDPs. The following Table 12 provides a summary of that data:

Table 12 - Least present features in each area of concern

Area of Concern	Features	Presence in percentage (%)
Anonymity	N/A	N/A
Iteration	E-mail tracking	33%
	QR code	33%
Controlled Feedback	Date Filter	17%
Statistical aggregation	Data analysis tool	33%
Implementation Features	Predefined themes	0%
Participant User-Friendliness	Auto-saving answers	33%
	Live chat	0%
	Chat bot	17%

Although these features are poorly explored by the sample of WDPs used in this study, these features can bring many benefits in Web-Delphi practice. The following points translate some of the benefits that these features can bring to the Web-Delphi Platforms:

E-mail Tracking: One of the main problems in using these WDPs, is that although they have a built-in e-mail system that allows facilitating the communication between the moderator of the process and the participants, this built-in e-mail system can also bring some obstacles to the Delphi process. According to the conclusions drawn in the interviews, one of the problems concerning the use of this system is that the emails sent can be moved to the participant's spam box. The

Spam Box is an e-mail inbox that does not use notifications and consequently does not warn the receiver regarding the arrival of an e-mail. Thus, the moderator may be left in doubt and may think that the person has simply ignored the request to participate. As we know, the dropout rate of participants in Delphi processes is one of the big problems associated with the Delphi method and so there must be ways to mitigate this. Using email tracking allows the moderator to see if the emails have been received and read by the participants and to better manage participants and their emails.

QR code: Nowadays people are increasingly using their cell phones to answer online surveys because of their ease of access and convenience. One of the technologies that allow the use of the cell phone camera to access websites is called a QR code. Besides that, it is a good practice to have alternative ways to access the survey (in case one is not working, for example), the QR code can be very beneficial in other ways. Let's imagine that a Web-Delphi study was being prepared and that the study consisted of using people who frequented the facilities of the Instituto Superior Técnico as participants. One way to get people to participate would be distributing flyers around the buildings with an explanation of the study and a QR code in case people were interested in taking part and contributing to the study.

Date filter: This feature can be a very useful tool in the analysis of results for each round. This feature allows the moderator to establish a temporal period of analysis where the results obtained are only relative to that period. Let's imagine that a Delphi study regarding a moral and delicate subject like euthanasia is in progress, but that during one Delphi round of the process a study that represents a new insight regarding this subject is published. Using this feature, the moderator can study the impact that this study had on the results and changes in the participants' opinions during that round.

Data analysis tool: Even though it is barely present in the mentioned WDPs, the Data analysis tool is probably one of the most impactful features in Web-Delphi practice. As we know, one of the main tasks that a moderator usually has in an online Delphi process is to export and process data to assess whether there is stability of responses and to assess whether consensus has been reached among the group of participants. As platforms have evolved, they have become increasingly autonomous and optimized for the implementation of Delphi processes. Mesydel and Calibrum are examples of WDPs that have this feature called "Data analysis tool". This feature allows automatic analysis of the data obtained in each round and calculates indicators such as "Consensus measurement" and "Group stability". The presence of this feature allows the process to become more automated, efficient, and faster, also reducing the moderator's workload. It also helps moderators who are not so familiar with the Delphi Method to understand the results obtained.

Predefined themes: This feature is not present in any of the WDPs but was highly valued according to the conclusions obtained in the interviews. Predefined themes can be a huge advantage when building a Web-Delphi process in a WDP. The presence of this feature not only allows reducing the time associated with the construction of the questionnaire but also helps the moderator to think about how he/she will implement his/her process in the questionnaire format. For example, a moderator who is unsure about which question type (dropdown, group button, radio button, etc.) to use to construct a particular question, the use of predefined themes can be a way to allow the moderator to visualize how the question would look in the survey without having to go through the effort of creating it first.

Auto-saving answers: This feature consists of the ability to automatically save the participants' answers. Imagine that a participant was answering a very long and exhausting questionnaire and for some reason, the electronic device he was using turned off and the answers had not been saved. This event could cause annoyance to the participant and even cause him to give up due to the time that the questionnaire is consuming. The way to overcome these events is to have a feature that allows you to save the participants' answers automatically without requiring any action from the participant. As shown in the results only two WDPs, Welphi and Mesydel, had this feature fully present. However, the remaining platforms all feature semi-automatic saving, meaning that when participants click to proceed to the next page of the quiz, the answers from the previous pages are all saved, but if a participant answers a page of the quiz and accidentally closes that page, none of the answers from that page are saved. Calibrum has a particular feature that consists of auto-saving only the answers given in radio buttons, while the other question types have only a semi-automatic saving.

Live chat and Chatbot: Due to their high similarity, these two features will be commented on together. Both valued during the interviews, Live chat, and Chatbot are features that can benefit not only the participant but also the moderator. The existence of a Chatbot or Live chat that allows the moderator to communicate with the technical staff of the platform is very beneficial because it can be a way to clarify possible doubts of the moderator regarding the operation of the platform in a faster way. On the other hand, a Live chat can also be beneficial to the participant in case it is a Live chat between the participant and the moderator that allows the participant to clarify possible doubts with the moderator instead of having to go through the effort of sending an email. Therefore, Live chat and Chatbot are great tools to facilitate communication involved in online Delphi processes.

6. Conclusions and Future Work

After applying the Framework and analysing the respective results obtained, it was possible to achieve the objectives previously outlined for this study. It was concluded that although all these WDPs were designed for the same purpose (application of the Delphi Method), these platforms present some diversities among themselves. Although most of the features that were considered valuable in the implementation of online Delphi processes were present in most of the platforms, a portion of these features was not present in them. Therefore, the present work also explained the benefits and contribution that each of these features can have in the implementation of Delphi online processes even though they are poorly explored on these platforms. It was also possible to analyse the development of each concern area outlined in the Framework, and understand which ones need more development, which ones have a more homogeneous

presence in the platforms, thus understanding which areas are more bet on today by the platforms. As future work, it is recommended to reapply the search protocol to find possible emerging WDPs that were not included in this dissertation and consequently apply the WDP Features Framework to these platforms. Since part of the found WDPs were not selected for analysis due to cost constraints, it would also be beneficial to apply the WDP Features Framework to these platforms in future work. Since the costs of using each WDP were not considered in this dissertation, it is also recommended to perform a cost-benefit analysis on them. Since it was also proposed a multi-criteria model adopting the MACBETH approach to help a possible decision-maker to choose a WDP for online Delphi study implementations, it is also recommended the future construction of this model and consequent application. In conclusion, it is intended that this work be considered a useful tool in the analysis of Web-Delphi Platforms as well as a contribution to their development.

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