

Industrial processes integration

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June 2018

Top bottom procedures to develop multicriteria evaluation models have been widely used in the most diverse areas of application. However, the application of this approach in corporate environments is very little documented or not at all. Aiming to contribute to this literature, while solving a real decision problem of an oil & gas company regarding the selection and implementation of a data integration platform, this dissertation applies a framework combining concepts of multicriteria value measurement with participatory processes giving special emphasis to the development of two modified web-Delphi processes technically sound in MACBETH. These were developed in order to make clear the value system of the actors engaging in the processes through the collection of their value judgments in the form of qualitative pairwise comparisons between performance scale levels on each one of multiple evaluation criteria and their weighting, respectively. On the one hand the resulting outcomes of this processes regarding the decision problem at hand, served as feed in information for the company to construct the aimed multicriteria evaluation model, having a strategic group make final decisions based in the provided compilation of judgments from the participants in the Delphi processes. On the other hand these provided valuable insight regarding the reliability of Delphi developed in corporate environments.

Key-words: Top bottom; multicriteria evaluation model; Participatory processes; Delphi; MACBETH.

1. Introduction

The oil & gas industry are leaders in technology innovation when it comes to the extraction, production, and pipeline delivery of fuel energy. However, many oil & gas producers are still catching up when it comes to optimizing business processes. The supply chain has many moving parts, and the more of those parts you can automate the more it benefits every partner in the value chain. Being fully aware of this global trend for automation of business processes and of the benefits it has to offer, Galp has felt the need to step into this new era aiming at data automation integration of its industrial process. Galp is an integrated energy player being the only integrated group of petroleum products and natural gas in Portugal. In this context Galp is undergoing a transformational moment within the processes involved in the Oil management, which demands actions with a structural impact on information systems and how they integrate and support the business processes. Galp intends to implement

an integration platform aiming at higher integration, flexibility, coordination and efficiency, easing the access to information so as to support better decision making and improve the capacity to respond to market moves. In order to do so an internal contest was carried out at Galp for tenders to present their solutions to this problem. This study comes in this context answering to a specific call from the company. To evaluate tending options and appraise the best Enterprise Management System solution, i.e. data integration platform, proposal the construction of a multicriteria evaluation model was in place. The purpose of this study is to present the work developed by author, collaborating with Galp, towards the model building process highlighting the practices carried out by IST.

The application of top-bottom approaches for developing multicriteria evaluation models is widely in practice in the most diverse areas of application. Studies regarding the employment of technics for breaking down the value systems of

the actors have been made available through documentation. However the case regarding corporate environments is much different due to the property nature of the developed practices and results. In this context this study suggests and applies a social-technical methodological approach to the problem of breaking down the value system of the actors in corporate environments through the district working areas of the company, combining concepts from multicriteria value measurement with participatory methods to build the multicriteria evaluation model. To enable the evaluation of options participatory Delphi processes (non face-to-face) and Decision Conferencing processes (face-to-face), are developed respectively. The employment of the latter to wrap up the process is known to be necessary and justifiable due to the complexity of developing evaluation multicriteria models without face-to-face interactions. Thus the focus of is the employment of two modified web-Delphi processes technically sound in MACBETH (Measuring Attractiveness by a Categorical Based Evaluation Technique) to collect value judgments of an enlarged group of participants to inform the decision conferencing processes, in the form of qualitative pairwise comparisons between performance scale levels on each one of multiple evaluation criteria and their weighting, respectively.

Literature emphasizes the benefits of Delphi studies in other contexts where these have revealed to be a major asset. The efficiency of top bottom approaches is known to be questionable in contexts where pressures from dominant actors are present, as is the case of corporate environments having a hierarchical structure of employees. Anonymity being one of the key features of a Delphi process allows for the value system of the actors engaging in the process to be “freely” expressed undoing pressures to conform. Furthermore the employment of multiple rounds in the Delphi processes contributes to the assessment of the reliability and stability of the answers provided by the participants in the processes. Finally the use of a web-based environment to develop the Delphi processes is tested aiming at increasing

the efficiency of the Delphi processes through automation of the practices involved in this participatory method.

Key literature ideas related to the context in which this study is insert follow next, with the purpose of framing the decision problem at hand in a theoretically context and to configure the adopted approach. Projects of evaluation and selection of EMS are of extreme dimension and importance to organizations. The most important recognized factor related to the failure of these projects is the lack of appropriate criteria within the framework of the project's sphere. Hence, the task of assessing these is of vital importance for the project to succeed. MCDA has been found to be a powerful tool in problems dealing with multiple criteria. The MACBETH approach in the decision making scope is presented as a technique which aims at the scoring of available options on an interval scale of measurement through the development of a multicriteria model evaluation. MACBETH possesses the advantage of abstaining decision makers to have to directly assigning the numerical scores required by other techniques, when dealing with the model building tasks. Participatory methods have proven to be very useful in aiding the social component of MCDA's framework, providing several ways for the incorporation of the actors' input into the process while enabling the creation of a shared understanding of the issue. The Delphi method enables the involvement of the actors in the process of model building while keeping anonymity of the actors, thus preventing the external influences of the group of actors in one's input.

The structure of this report is presented as follows: section 2 presents the methodological framework applied; section 3 presents the selected results and analyses of the application; finally section 4 discusses the outcomes of the application.

To preserve industrial confidentiality some of the data presented have been altered or disguised.

2. Methodological framework

Methodologically the model building process used in this application can be described as social-technical, combining concepts from

multicriteria value measurement with participatory methods to build the multicriteria evaluation model. From the technical side the MACBETH approach was used to construct the model within a hierarchical multicriteria model structure, whereas from the social side the application of MACBETH was supported by a combination of participatory methods including modified web-Delphi processes and decision conferences. It is important to acknowledge the constitution of two different groups of decision makers to develop the sequence of interconnected process activities predicted: a panel of participants (having different perspectives and skills which can provide valuable insights to the construction of the model) in the web-Delphi processes and a strategic group (having a holistic view of the model-building process therefore enhancing the effectiveness of the process). Having different specificities both groups were designed to participate in distinct formats in different parts of the model building process. The referred process activities to be developed with both groups, in the scope of both the social-technical approach and the preceding activities of criteria definition and operationalization, are displayed in *Figure 1* into two many phases of analysis: structuring and evaluating. The scheme displayed (*Figure 1*) is a valuable tool to clarify and ease the perception of the workflow, providing a visual representation of the way the process of model

building unrolled. The methodological basis for the building of the aimed model is now presented in more detail.

2.1. Structuring activities

During the structuring phase screening and evaluation criteria were identified and operationalized.

2.1.1. Screening criteria

Screening criteria are focused on tenders' potential rather than on their specific tending proposal, only being used for tending proposal screening with the aim of prequalifying options.

Seven openings were available for seven tending proposals in the evaluation phase yet to come. However 15 tenders responded to the call upon the opening of the contest. This implied a screening action in order to shortlist the tending proposals to the target seven, enabling them to migrate to the evaluating phase later on. In order to accomplish this, screening criteria were established. Screening criteria were settled through an interaction amongst the strategic group members, assuring these encompassed all software and vendor requirements necessary to meet the company's needs of an EMS solution. A total of 12 screening criteria were identified and sorted into two areas of concern: IT solution and services. Ten of the identified screening criteria accounted for the IT solution and the remaining 2 for the services. The criteria were then grouped into families and organized into four PVs as follows: i) Functional requirements; ii) Technical requirements; iii) Credentials; and iv) Partners.

2.1.2. Evaluation criteria

Evaluation criteria are meant to evaluate proposals as the denomination itself suggests and should be carefully selected.

In order to evaluate the seven tending options which were able to pre-qualify from the screening action, it was necessary to set the evaluation criteria. Instead of coming up with a brand new set of criteria, it was the company's decision to establish the evaluation criteria based in the previously considered screening criteria. This was due to the fact that the screening criteria were found to roughly cover all

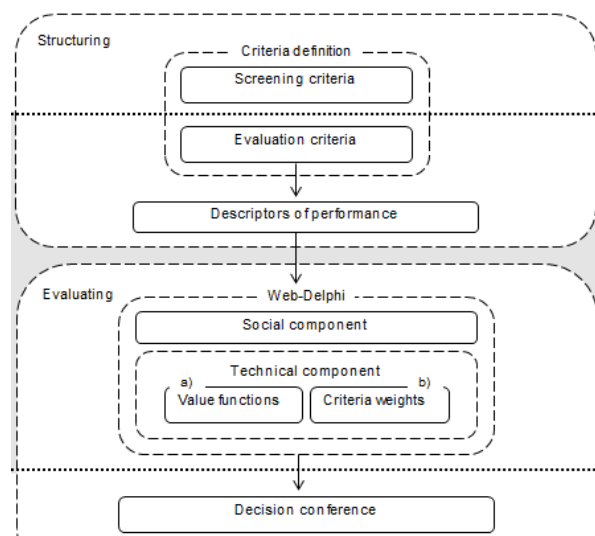


Figure 1. Model building activities. The section where each activity is presented in more detail is noted.

the necessary characteristics regarding the optimal EMS solution. Thus as part of the procedure for accomplishing the evaluation criteria the previously considered screening criteria underwent a refinement and adjustment procedure to enable tending options' evaluation. Prior to this refinement and adjustment proceeding, the settlement of the evaluation criteria began with an analysis of the whole screening criteria set. Criteria found to be related to tenders rather than their tending options, thus relevant for screening but not for evaluating the options, were eliminated. As a result of this exercise two out of four previously considered PVs, and respective criteria sorted into them, were considered for evaluating the tending options: i) Functional requirements and ii) Technical requirements. The set of evaluation criteria was now ready to be refined and adjusted. The refinement and adjustment of the selected criteria was carried out reassessing the criteria to make sure they respected the necessary conditions that make them qualify as so hereinafter: be intelligible; be consensual; be isolable; be operational. Operationalization of the criteria was also assured through this practice. Time was not an evaluation concern in this project because Galp imposed a compulsory deadline from the start that tenders were fully aware. The ten benefit criteria (evaluation criteria set) were materialized over this entire process following the company's own interpretation as follows:

- 'Capture' - Capture data from different data sources systems and different data types, providing validation and cleansing capabilities, and keeping track of all versions.
- 'Storage' - Store different data types and frequencies, with definition of data imperativeness and owners, ensuring its quality and proper governance.
- 'Display' – Analyze and compare data sets within the platform, given a set of predefined charts and reports and allowing user made reporting.
- 'Assess' – Calculation engine and definition of workflows in order to improve collaboration between areas and the flow of data, allowing

the quick identification of bottlenecks and critical paths.

- 'Alert' – Notification of relevant events, providing KPIs and dashboard to keep an up-to-date view of the critical processes' variables in the value chain.
- 'Distribute' – Mechanisms to access raw and aggregated data, automatizing its extraction on multiple formats, and enabling ad-hoc queries within the platform or through an Excel add-in.
- 'General' – User-friendly platform, with customizable Graphical User Interface and managing different time zones.
- 'Integration' – Bidirectional integration with the different systems supporting the Oil Value Chain and logging capacity.
- 'Security' – Definition of user profiles and permissions on the different levels, with full user and activity log, and providing database encryption.
- 'Mobility' – Access to the platform in remote using a browser enabled client and/or a mobile application.

2.1.2. Descriptors of performance

A key task in building an indirect-evaluation model consists of associating with each of the considered criteria a descriptor of performance. Descriptors of performance measure the extent to which the criteria can be satisfied, while making them operationalized. The development of these is directly linked with the construction of scales, which enable the ranking of the multiple criteria.

Qualitative, constructed and discrete descriptors of performance enabling criteria operationalization were accomplished allowing, for the construction of multidimensional scales for the criteria that clustered several intertwined dimensions, as follows: two reference levels, good and neutral, were defined; More levels were added to cover the plausible range of performances; Each level of performance descriptor was carefully described to ensure a clear and unambiguous interpretation of its meaning. The final constructed scale regarding 'capture' as an example is shown in Table 1. As it is possible to observe in the above table

'capture' becomes operational based on a constructed scale of four ordered performance levels within the range of plausible impacts, presented in decreasing order of attractiveness according to Galp's view.

Table 1. Operationalization of 'capture'

| Capture | |
|------------------|--|
| Bad | There are no validation capabilities or data governance functionalities. |
| Neutral | Capture all required batch data with different and providing validation capabilities, but without out-of-the-box connectors to Galp's architecture. Capability to define "data owners" is also required. |
| Good | Most of the batch data can be captured on-demand and through an out-of-the-box connector and a validation workflow for data correction along with data cleansing capabilities is provided. |
| Very Good | Near real-time out-of-the-box connectors that replicate the data model of Galp's architecture, reducing the maintenance effort for major upgrades or new systems implementation. |

3. Evaluating activities

The start of the evaluating activities described in this section marks the employment of the earlier mentioned social-technical approach. Reaffirming, this approach comprises two participatory processes: Delphi (non face-to-face) developed with the panel of participants; and decision conferencing (face-to-face) developed with the strategic group. The Delphi processes are meant for the extraction of valuable input from participants, concerning their judgments regarding a potential EMS solution. Information attained from the processes will feed in the decision conferencing process helping the strategic group to make final decisions, as informed as possible, aiming at the multicriteria evaluation model's construction.

2.2. Web-Delphi processes

Two web-Delphi processes were developed extracting information to help determine the added and the partial value of the evaluation

criteria through the assessment of both the criteria's value functions and weights required in the scope of the additive aggregation model. These were developed according to the following order and objectives:

- a) 1st web-Delphi – Value functions: Collect qualitative pairwise comparison judgments between performance scale levels on each one of the multiple pre-defined criteria.
- b) 2nd web-Delphi – Weighting criteria: Collect qualitative judgments of importance of swinging between least and most preferred performance levels on the criteria.

Both modified web-Delphi processes were developed in three sequential rounds where the main goal was not to reach consensus but to acquire the opinion of the panel through a structured process. Therefore participants were consulted three times in each one of them. This provided the panel with the opportunity to reconsider their answers given in previous rounds. A description of each one of the considered criteria was always available for consult as were the correspondent levels of performance to be considered along with their conforming description. Controlled feedback was given in each round, informing the group members of the opinions of their anonymous colleagues. The design of both web-Delphi questionnaires was accomplished resorting to an online platform specially developed for the purpose of carrying out web-Delphi processes: the Welphi platform (www.welphi.com).

After implementing the design it was possible to launch the Delphi processes that were both generally organized as described below:

- Through a briefing document internally disclosed at Galp the modified Delphi processes and questioning procedure were explained in detail. The provision of the information with regard to both the criteria and their descriptors of performance was not necessary as the questionnaires to be made available on the online platform where exhaustively detailed with respect to that information.
- Each panel member then received an invitational e-mail containing their username and instructions to access the online platform

were they were required to set their password in order to assess the questionnaire (being this their first interaction with Welphi); in this platform each participant answered to the questionnaires using the MACBETH qualitative scale in both Delphi processes. In addition a 'don't know/don't want to answer' option was available to be selected and participants could provide any comments they saw fit. Once the participants had given their answers the 1st round was closed

- In the 2nd round, feedback concerning the results of the 1st round was provided to each of the panel members which successfully engaged in the previous round, thus enabling their continuous participation in the processes. An invitation to take part in this 2nd round was sent by e-mail enabling their access to the questionnaire. Along with the supplied feedback participants were also reminded of their individual answers given in the 1st round. Participants now had the opportunity to revise their answers either keeping or changing them. A justification regarding a change in the answers was neither required nor compulsory although participants could provide any comments they saw fit as in the 1st round. This ended the 2nd round of the Delphi processes.
- In the 3rd round, updated feedback concerning the panel's answers was provided along the same lines as the ones considered in the 2nd round. Similarly participants still engaging in the process were invited to revise their previously given answers in the 2nd round. Once more, an invitation to take part in this 3rd round was sent by e-mail enabling their access to the questionnaire. Again comments could be provided whenever participants saw fit. This ended the 3rd round.
- Finally a final report with the results of the modified Delphi processes was elaborated and sent to all the original members of the panel, regardless of their participation through rounds. This report contained the answers provided from all the participants in the processes in the 3rd and final round as well as a summary of the participants' comments if there were any. Through this the Delphi processes were at last finished.

Panel of participants

Participants in the processes were either employees at Galp or were collaborating with the company in the scope of the selection and implementation of the EMS solution. These were selected from district working areas within the company by Galp, being these future users of the platform and experts. The panel was composed by a total of 68 members divided into two smaller groups (61 and 12 participants) according to their expertise and skills. Each of the groups was responsible of providing judgments for a set of criteria related with their area of knowledge and experience (functional or technical).

Social component

In addition to the briefing document internally disclosed at Galp, 'reminder' and 'last-reminder' e-mails were sent to the participants in the processes whenever the previously established deadlines for closing the processes' rounds were approaching and participants hadn't manage to engage in the processes. These normally would either encourage them to participate in the round before it finished or inform them that time extensions were being employed and rounds would remain further active, respectively.

Technical component

a) Value functions

In order to assess the value functions corresponding to each one of the considered evaluation criteria regarding the EMS solution's appraisal, a single question was developed. This was done exploiting the use of MACBETH regarding qualitative increases in preference between each two consecutive levels of performance, considering the criteria one by one. Participants were able to access the questionnaire that would allow determining their main concerns on each criterion regarding the increase in preference between each two levels of performance. In the 1st round Participants were asked to answer the following question: "With regard to this criterion, which do you consider to be the increase in preference between each two levels of performance?" Answers were provided according to the

MACBETH qualitative judgment scale through the selection of one of the following alternatives: 'no increase', 'very weak increase', 'weak increase', 'moderate increase', 'strong increase', 'very strong increase' and 'extreme increase'. In addition a 'don't know/don't want to answer' option was also available for selection and comments could be provided.

The sequence of the participants' answers to the three questions regarding each criteria, enabled to extract their implicit main concerns for each criterion. In the 2nd round participants were presented with their individual pre-selected main concern appeared highlighted in a dark-grey cell. These were invited to either keep or change each pre-selected main concern at the light of the group information shown in the table. Finally in the 3rd round participants were presented with the distribution of the panel's main concerns selection in the previous round. Feedback with the results of the 2nd round was updated on each criterion. Participants could maintain or change the main concern selected in the 2nd round at the light of the group information provided.

b) Weighting criteria

In order to assess the criteria weights corresponding to each one of the considered evaluation criteria regarding the EMS solution's appraisal, a single question was developed as for the case of the modified Delphi for value function. Participants were able to access the questionnaire that would allow for the collection of their value trade-off judgments regarding each of the considered evaluation criteria. The questioning procedure was carried out similarly to the questioning procedure of the web-Delphi for value functions, but this time no main concerns were assessed and the direct answers of participants to the question "Regarding the selection of the proposal for an [REDACTED] integration platform that best meets Galp's needs, suppose there is a proposal with neutral performances in all criteria. What would be the importance of improving it from neutral to good on each of the criteria?" were taken as direct results. Answers were provided with the MACBETH qualitative judgment scale through the selection of one of the following alternatives:

'no importance', 'very weak importance', 'weak importance', 'moderate importance', 'strong importance', 'very strong importance' and 'extreme importance'. In addition a 'don't know/don't want to answer' option was also available for selection and comments could be provided.

2.3. Decision conferences

A report meant for the strategic group providing feed in information for the model's construction processes was drawn up in the conclusion of the Delphi processes. This included their summary results as well as a preliminary analysis of these. Feedback was reported informing that outcomes of the Delphi processes presented in the report were used as expected to construct the multicriteria evaluation model.

3. Results and analysis

Results from the processes produced information for each criterion in the form level of agreement percentages. Analysis was performed by screening these to detect the existence, or not, of a majority within the panel. By group majority main concern, it is meant at least 51% of the participants selected a determined answer.

4.a. Web-Delphi for value functions

4.a.1. Functional evaluation panel

1. Results

In the 1st round, a total of 61 participants were invited to engage in the process. From the 61 invited participants a total of 31 participants concluded the questionnaire (51% adherence corresponding to a dropout rate of 49% among panel members). The 31 respondents from the 1st round were invited to take part in the 2nd round of the process. Of these 31 invited participants, a total of 26 participants concluded the questionnaire (84% adherence corresponding to a dropout rate of 16% among panel members). Finally, these 26 respondents were then invited to participate in the 3rd and final round, having 24 of them concluded the final questionnaire (92% adherence corresponding to a dropout rate of 8% among panel members).

2. Analysis

The 2nd and 3rd rounds present group majority main concerns regarding all the criteria. Being that from the 2nd to the 3rd round all the group majority main concerns present themselves stable, in terms of the selected group majority main concern, while slightly increasing the percentage of selection by the participants. It should also be noted that some of these increases lead to a group consensus (100%), as is the case of 'display', 'alert' and 'general'. Another point of focus is the particular case of the assess criterion. This presents group majority main concerns in all three rounds. Nevertheless, it can be seen that the group majority main concern implicit in the participants' answers in the 1st round is not the same as the group majority main concern selected in both the 2nd and 3rd rounds.

4.a.2 Technical evaluation panel

1. Results

In the 1st round, a total of 12 participants were invited to engage in the process. From the 12 invited participants a total of 10 participants concluded the questionnaire (83% adherence corresponding to a dropout rate of 17% among panel members). The 10 respondents from the 1st round were invited to take part in the 2nd round of the process. In this 2nd round all of the 10 invited participants completed the questionnaire (100% adherence corresponding to a zero dropout rate among panel members). Finally, these same 10 respondents were then invited to participate in the 3rd and final round, having 8 of them concluded the final questionnaire (80% adherence corresponding to a dropout rate of 20% among panel members). The web-Delphi proceeding for value functions concerning the functional evaluation panel produced information for each criterion in the form level of agreement percentages.

2. Analysis

Group majority main concerns were reached in both the 2nd and the 3rd round. These majorities are stable and all of them present an increase in the percentage of participants that selected the main concerns in question, going from the 2nd to

the 3rd round, reaching consensus in the 3rd and final round regarding all the criteria.

Overview

With respect the functional criteria panel, the three criteria that reached group consensus were: 'display', 'alert' and 'general'. Still regarding the functional criteria panel, in one criterion ('general') the selected group majority main concern was a constant increase in preference (from worst to best performance), while in other two criteria ('display' and 'alert') the selected group majority main concern was achieve a good performance and for another four criteria ('capture', 'storage', 'assess' and 'distribute') it was to achieve a very good performance. Considering the technical criteria panel, all of the three criteria achieved group consensus. Each one of the three criterion of the panel had different selected group majority main concern; in one criterion ('integration') the selected group majority main concern was to achieve a very good performance, in another ('security') it was to avoid a bad performance and finally to avoid a bad and achieve a good performance in the other ('mobility').

4.b. Web-Delphi for weighting criteria

4.b.1. Functional evaluation panel

1. Results

In the 1st round, a total of 61 participants were invited to engage in the process. From the invited participants a total of 37 concluded the questionnaire (61% adherence corresponding to a dropout rate of 39% among panel members). The respondents from the 1st round were invited to take part in the 2nd round of the process. Of these a total of 26 concluded the questionnaire (70% adherence corresponding to a dropout rate of 30% among panel members). Finally, these 26 respondents were then invited to participate in the 3rd and final round, having 20 of them concluded the final questionnaire (77% adherence corresponding to a dropout rate of 23% among panel members). Finally, these 26 respondents were then invited to participate in the 3rd and final round, having 20 of them concluded the final questionnaire (77%

adherence corresponding to a dropout rate of 23% among panel members).

2. Analysis

In the 1st round only the 'display' criteria achieved a group majority judgment. This particular group majority judgment was stable through the three rounds, having an increase in the percentage of selection by the participants in both the 2nd and 3rd rounds. In the 2nd round five out of the seven panel criteria manage to achieve group majority judgment and in the 3rd round, six out of the seven criteria achieve the group majority judgment. Regarding the stability of the group majority judgment through the 2nd and 3rd rounds, all of the considered criteria maintained a stable selected group majority judgment, with the exception of the 'assess' criterion which suffered a change in the selected group majority judgment going from the 2nd to the 3rd round.

4.b.2. Functional evaluation panel

1. Results

In the 1st round, a total of 12 participants were invited to engage in the process. From the invited participants a total of 11 concluded the questionnaire (92% adherence corresponding to a dropout rate of 8% among panel members). The 11 respondents from the 1st round were invited to take part in the 2nd round of the process. Of these a total of 7 concluded the questionnaire (64% adherence corresponding to a dropout rate of 36% among panel members). Finally, these 7 respondents were then invited to participate in the 3rd and final round, having 6 of them concluded the final questionnaire (86% adherence corresponding to a dropout rate of 14% among panel members).

2. Analysis

Group majority judgment was reached in both the 2nd and the 3rd rounds regarding the 'integration' and 'security' criterion. Both this criteria present stable selected group majorities, going from the 2nd to the 3rd round, while slightly increasing the percentage of selection by the participants. In the case of the 'security' criterion the referred increase leads to a group consensus

(100% of the participants selected that main concern). In the particular case of 'mobility', the selected group majority judgments sifted between a moderate importance judgment, in the 1st and 3rd rounds, and a strong importance judgment in the 2nd round.

3. Overview

With respect the functional criteria panel, the General criterion didn't reach a group majority judgment. Still regarding the functional criteria panel, in four criteria ('storage', 'display', 'alert' and 'distribute') the selected group majority judgment was a judgment of strong importance and for another two criteria ('capture' and 'assess') it was a judgment of very strong importance.

Considering the technical criteria panel, 'security' reached group consensus judgment. Two ('integration' and 'security') out of the three panel criteria achieved a very strong importance group majority judgment, while the other criterion remaining ('mobility') achieved a moderate group majority judgment.

4. Discussion

i) Contributions to Galp's decision problem

Resorting to a web friendly environment for the development of the Delphi questionnaires through Welphi proved to have very positive outcomes. The management of responses and nonresponses is a critical aspect in all Delphi studies. The facilitation team is responsible for the administration of the Delphi process's playing a fundamental role in its success. The use of the Welphi platform to deliver the questionnaires and to follow-up on the processes increased the efficiency of the process and Delphi procedures, easing data entry, responses and analysis. It simplified the process of gathering information from the panel, and enhanced the controlled opinion feedback and communication across rounds. The Welphi platform allowed monitoring the participation, which was important to reduce drop-out.

Corporate utilization of Delphi is perhaps one of the least-known aspects of the technique's application. This is a result of corporations regarding the products of their Delphi exercises

as proprietary and, hence, restricting their distribution or description in professional literature. A review of the long-term planning and futurist literature has revealed that few of the corporate efforts in this field have been documented in any detail making it hard to examine this variable's contribution to the attained outcomes of both Delphi processes [43]. Validity refers to the confidence placed in cause effect relationship. In this context validity of resulting outcomes of the Delphi processes developed in this dissertation is placed in the attained results for measuring the value system of the actors regarding the appraisal of an EMS solution. Unexpected outcomes contributed against the effort made through Delphi's technicalities, aimed at increasing the validity of the results, namely the verified dropout/response rates and response bias. These are expected to be linked to the social components of Delphi. On the one hand validity of the resulting outcomes of both implemented Delphi processes was attained considering the value system of the participants involved in a general way, even if it indisputably it could've been higher (provided a higher response rates). On the other hand, the assessment of the validity concerning the value systems of the participants through the district working areas of the company is not possible mainly due to bias in the process as explained above leading to low representativeness of the different working areas in the results (also not assured at the start of the processes as addressed above). Having said this, the assessed validity is expected to contribute to a high general acceptability of the EMS solution in the company, when implemented.

ii) Contributions to the literature

This study contributes to the literature by exploring the use of Delphi in corporate environments to assess the value system of the actors in a top bottom approach to inform a decision conferencing process in the context of developing a multicriteria evaluation model to solve a decision problem at Galp. This study adds to the literature namely by: 1) from the practical viewpoint, promoting a level of agreement among a range of participants from different areas of knowledge on which criteria

are most relevant for appraising an EMS solution in a corporate environment. 2) from a methodological perspective, by employing participatory Delphi processes and applying statistical analysis of responses that can be used in the multicriteria evaluation model's construction to evaluate potential EMS solutions. 3) and from the technology side, by presenting an innovative web-platform that enables the use of participatory processes and its monitoring.

5. Conclusions

The presented work was framed in the scope industrial processes integration in the Portuguese oil & gas company, Galp. The company intends to implement an integration platform aiming at higher integration, flexibility, coordination and efficiency, easing the access to information so as to support better decision making and improve the capacity to respond to market moves. This study fulfilled its initially proposed objective by generally assessing the value system of an enlarged group of actors regarding the appraisal of an EMS solution to be implemented at Galp. Normally this type of corporate decisions intake a more centralized approach where only the value systems of e.g. head board members are taken into consideration. Thus this is a most valuable study emphasizing the potential of developing Delphi processes in corporate environments in the context of decision making.

Ultimately this study provides a comprehensive and sound analysis of the application of Delphi processes to inform the construction of a multicriteria evaluation model for the selection. Furthermore, it highlighted the usefulness of relevant use of future users of the platform and experts involvement, showing their existent view points and perceptions. The findings can inform future research on Delphi processes developed in corporate environments. Future research regarding several "blind spots" regarding Delphi's implementation in corporate environment require enlightenment in order to implement these in the best possible and adapted way as to increase even further the reliability of the outcomes.