Doctoral School on Engineering Sciences
Università Politecnica delle Marche

Extended summary

# Innovative Applications of Q Methodology in Socio-Economic and Environmental Research

*Curriculum: Ingegneria Informatica, Gestionale e dell'Automazione*

Author

Serena Mandolesi

Tutors

Prof. Raffaele Zanoli

Prof. Simona Naspetti

Date: 30-01-2014

---

**Abstract**. In this thesis the quali-quantitative approach of Q Methodology is used for a systematic study of human subjectivity outside the research field in which it was originally developed by the psychologist and physicist William Stephenson in 1935 [1].
Contrary to quantitative research methods, the main aim of Q Methodology is to identify the existing perspectives on a specific topic and not to quantify how many individuals adhere or not to those perspectives. The essence of this methodology is that it makes a nonconventional use of the multivariate statistical method of factor analysis: shifting the attention from variables to persons, the correlation matrix expresses the degree of correlation of each person towards any other person. Q Methodology gives more structure to subjective opinions and allows to identify those latent patterns across individuals that could not be revealed by non statistical methods. According to the methodology, this purpose is reached asking participants to rank-order a set of *stimuli* (i.e. verbal or non-verbal *stimuli*) basing on their point of view. Data collected with the form of *Q sort* are then intercorrelated and subjected to factor analysis. The researcher is asked to conceptualize

participants' point of view interpreting the emerging factors.
The introductive part briefly examines principles and procedural aspects of this method. Then, four empirical applications are presented. The first application regards mobility behaviour in 6 towns all belonging to the province of Ancona. The second study explores the acceptability of some innovations in low input and organic dairy sector in four European countries (Italy, the United Kingdom, Belgium and Finland), within the UE project SOLID ("Sustainable Organic and Low Input Dairying").
Follow two studies on the use of images to assess the subjective perception of familiar and unfamiliar landscapes: the first is an assessment of the perceived impact of photovoltaic systems installations in rural and urban in relation to the Marche region; while the second explores, within the Italian research project RITMARE, the subjective importance of the Mediterranean deep-sea ecosystems services by the use of different conditions of instruction.
The thesis aims to deepen the knowledge of Q Methodology, demonstrating its potential value of revealing individuals' perspectives. Finally, this work has the objective of expanding the use of this methodology in socio-economic and environmental research.

**Keywords.** Q Methodology, Subjectivity, Visual Q, Innovation, Landscape, Transport Mode Choice

# 1 Introduction

## 1.1 Motivation and Objective

The purpose of Q Methodology is providing a systematic study of human subjectivity [2]. This goal is pursued by investigating personal viewpoint of respondents who are asked to rank-order, according to a specific condition of instruction, a set of items about the topic of interest, extracted from a larger universe of opinions.
Q Methodology was originally introduced in psychology by the physicist and psychologist William Stephenson (1902-1989). Stephenson and his colleagues developed the relevant background literature and the basics of Q Methodology since 1930s, and now a great variety of examples are accessible for the Q researchers in many research fields (e.g. political science, medicine, education, etc.). The big variety of applications of Q Methodology renders this method suitable for exploring subjective perspectives, adding complementary information to classical qualitative and quantitative researches when the human dimension is central to the study.
Q Methodology consists of five steps [3]: construction of the concourse, development of the *Q sample*, selection of the *P sample*, *Q sorting* process, and Factor extraction. The concourse represents the universe of opinions around the topic under investigation. From this larger universe, a subset of items is selected to form the *Q sample*. Each participants of the *P sample* produces a *Q sort* by ranking the set of items, according to a specific condition of the instruction. Performing a *Q sort*, each respondent models his or her "self referent" perspective. *Q sorts* are then factor analysed and few relevant factors are finally extracted.
The non-conventional use of factor analysis represents the key-element of Q Methodology. Q Methodology emerged from the classical foundations of factor analysis and adapted this analytic method to behavioural research by shifting the interest from *by-variable* to *by-person* factor analysis [4]. In fact, the application of correlational and factor analytic approaches, developed by Charles Spearman and Karl Pearson, in new contexts such as behavioural research was a real novelty for such psychological studies [5].

## 1.2 Comparing Q and R approaches

Q Methodology was developed with distinct purposes from R methodologies [4][6]. Q approach was specifically created for understanding the patterns in the respondents' minds, correlating persons in a holistic manner across a set of items or *stimuli*, where each correlational value expresses the degree of agreement (or disagreement) among any pair of Q sorts. For this reason, it is an error to consider those approaches as opposites uniquely in terms of statistics, because they differ "in many other more important respects" [4].
In the definition of Q Methodology the letter 'Q' plays an important role. Thomson stated that the letter 'Q' stands for person correlation, distinguishing it from the famous correlation statistic of Pearson's r [4]. In R approaches, tests are used as variables and the process of correlation generates a correlation matrix, which is employed for the factor analysis. Each cell of this correlation matrix indicates the association value between all of the 'm' variables observed using a sample of people. As consequence, factor analysis is used to uncover the latent structure of a set of variables simplifying data in a lower number of variables know as factors. In this sense, the R methodological factor analysis can be viewed as a statistical method of data reduction. Stephenson was convinced that R methodological fac-

tor analysis could not discover in depth perspectives of individuals; it can only reveals the differences and the associations between variables [7]. This aspect represents a limitation to the application of the traditional R methodology on psychological issues. R approach prevents the possibility of finding the representations of a social kind, by a comparison of different viewpoints.

Usually, a typical factor analysis starts with the calculation of the correlations between all variables measured in a specific study. Certainly, these correlations have sense, if each score of the matrix has been standardized, this would make possible the comparisons between all the variables. In fact, in R methodology the standardization is necessary because variables in the matrix could not have the same unit of measurement. The standardization solves the problem of comparison between different variables like traits or characteristics, but clearly creates another problem: with the use of the standardization each individual or sorter is disassociated from the scores generated [8]. This aspect is absolutely in contrast with the aim of Q Methodology, where individual's subjectivity is studied in association with the subject's frame of reference. As consequence, the Q factor analysis, reporting Stephenson's words [7], doesn't need of "one and the same unit for all persons" it indeed needs "that the unit for any one person should be the same for the whole population of attributes".

The inversion proposed by Stephenson represented a quite relevant departure from the psychological tradition. As noted above, Q Methodology shifts from a *by-variable* factor analysis (the standard approach, which in Stephenson's papers was addressed as 'R methodology') to a *by-person* factor analysis (Q Methodology) [8]. By inverting the rows and the columns of a typical factor analysis, Q Methodology moves the focus from variables and patterns across variable to the inter-correlations and patterns across individuals [9]. Although the values of the correlation matrix are factorised in the usual way, they express the correlations between persons.

In addition Stephenson suggested "there never was a single matrix of scores to which both Q and R apply" [10]. In Q Methodology a new 'form' of data is required for the analysis and this different 'form' used to collect data represents one of the main difference between those approaches. In practice, during the process of Q sorting the respondent ranks data - a set of items - in a new 'form' - known as Q sort - reflecting his or her thinking without confining their choice to the researcher's categories. According to this the set of items forms the sample and the participants of the Q sorting process are equivalent to the experimental condition of an R methodology study [11].

In contrast to R approach, where it is assumed that exists a unique meaning of each question for the respondents, the Q researcher leaves each participant to define what is relevant or meaningful from his/her own point of view; and the association of a particular meaning of an item for a participant is related only in the context of the overall configuration reported in the completed Q sort.

According to Brown [12] the different perspective between R and Q approaches can be summarized as follows: "In the case of R methodology something is done to the person, as when we take blood pressure or measure height: this is the objective mode and the person's stance relative to measurement is passive. In the case of Q the person actively does something, i.e. measures or scales a population of measurable material: this is the subjective mode insofar as measurement is from the person's standpoint."

Other differences are associated to the scale of measurement. While in R, it is assumed that the all traits of each participant is measurable is somewhat degree, using a scale from "most to least" [4], in Q the scale used ranges for example from "like" to "unlike", having both the same significance for the study. The "zero" generates always confusion. In R methodology, the zero or the middle point means an average amount of the trait; in Q Methodolo-

gy the middle point is a neutral point that also creates a connection between the two opposite sides of the scale.
Generalization issue represents another crucial aspect. While for R methodologies the generalization to a larger population represents a main goal, for Q the interest is to generalize its results only to the universe of items about the topic of the study. Q Methodology has no interest in estimating population statistics because the aim is to include any perspective associated to the topic of interest in the *Q sample* and to "bring coherence to research questions that have many, potentially complex and socially contested answers" [13]. The same approach should be followed for the definition of the participant sample or *P sample*. Each person is chosen uniquely if he/she could provide a different perspective from the perspectives of the other respondents. For this reason, in Q, the *P sample* is not created randomly from a population, as in R methodology. In contrast to the R approaches, a Q methodological study requires only a limited sample of respondents [4].

## 2 Method & Data

### 2.1 Procedure

#### *2.1.1 Definition of the Research Topic and the Concourse*

A Q study starts with the definition of the research topic and the exploration of the discourse surrounding that topic, which in Q methodology is referred to as the concourse. In practice, the concourse is no more than the overall population of items about the domain under investigation and it is not restricted to words, but it might include: paintings, photos, music tapes etc. [4]. In most cases Q studies use verbal items and not non-verbal items, such as images, videos etc. The concourse can be gathered in several ways (e.g. using interviews or searching in secondary sources such as newspapers or literature). In practice the construction of a concourse is more similar to an art rather than a science [10]. See Table 1.

Table 1. Research Question for each Empirical Q study

| | Q study 1 | Q study 2 | Q study 3 | Q study 4 |
|---|---|---|---|---|
| Research Question | Studying subjective preferences of travellers in six small towns of central Italy (Province of Ancona) | Investigating the expectations of organic and low-input dairy supply-chain members in relation to innovations within the European project SOLID | Assessing the perception of the landscape impacts for the photovoltaic systems in the Marche region | Investigating how people perceive Mediterranean deep-sea ecosystem within the frame of the Italian research project RITMARE |

#### *2.1.2 Q sample*

Defined the concourse, a subset of items, called *Q sample,* is extracted from it and presented to the participants of the Q study to be ranked (See Table 2). To make these items fully representative of the concourse, the Fisher experimental design principles were applied, as suggested by Brown [2]. By applying this approach, a large number of potential items can be grouped into theoretical categories. These categories can usually be created via a deductive approach, which is based on a-priori hypothetical or theoretical concepts, or an inductive approach, where the categories emerge from patterns that are observed during the col-

lection of the items [3].

Table 2. Type and number of items for each Q sample

| | Q study 1 | Q study 2 | Q study 3 | Q study 4 |
|---|---|---|---|---|
| Item type | Statements on mobility experience and behaviour | Statements on dairy supply-chain innovations | Images on photovoltaic plants in rural and urban areas | Images on Mediterranean deep-sea ecosystems |
| N° items | 20 | 34 | 54 | 36 |

### *2.1.3 P sample*

The selection of the person-sample is an important process for the success of a Q study. Participants can't be selected randomly. P set is "more nearly theoretical (Glaser and Strauss, 1967) or dimensional (Arnold, 1970) than random or accidental" [4]. A good Q researcher should consider the relevant variables of the study and then be able to create enough variety between participants in order to identify main types of thoughts. To make sure that certain viewpoints are included in the study, the 'right' participants must reflect distinct positions. Q Methodology escapes from the "numbers games", adding more observations really don't influence the results of a Q study. P sample can be can be formed by 40-60 participants or [6]. Despite this, Brown continued to confirm that a good Q study can be carried out with lesser participant [4]. See Table 3.

Table 3. Type and number of items for each P sample

| | Q study 1 | Q study 2 | Q study 3 | Q study 4 |
|---|---|---|---|---|
| P sample composition | Citizens (Ancona, Falconara, Osimo, Jesi, Senigallia, Fabriano) | Dairy supply-chain members (consumers, farmers, retailers and processors) from 4 European Countries (Belgium, Italy, Finland, and the United Kingdom) | Experts (1 surveyor, 4 engineers, 11 among architects and urban planners and 3 agronomists) and non-experts. | 4 PhD students in Marine Biology and 4 from other faculties of Polytechnic University of Marche. |
| N° people | 42 | 99 | 34 | 8 |

### *2.1.4 Condition of Instruction and Q sorting*

The Q sorting procedure is the "technical means whereby data are obtained for factoring" [4]. Participants use the condition of instruction to place the cards following a predefined scale (e.g. from -4 to +4 or from 1+ to +9) and to a suggested distribution (usually a quasi-normal distribution). See for example Figure 1 and Table 4 and 5. The set of ranked items represents a complete Q sort for that individual.

Table 4. Q sorting scale used for each Q study

| | Q study 1 | Q study 2 | Q study 3 | Q study 4 |
|---|---|---|---|---|
| Extremes | From -3 to +3 | From +1 to +9 | From -5 to +5 | From -4 to +4 |

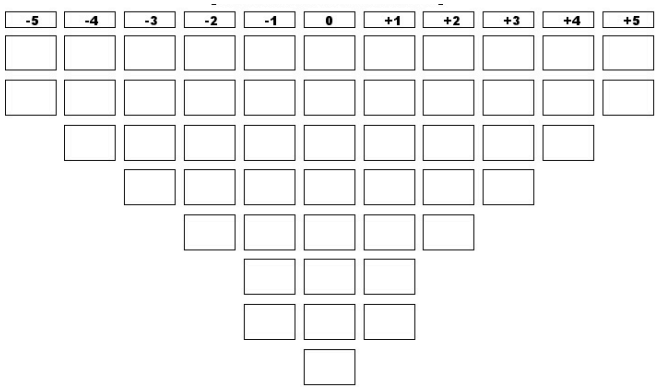


Figure 1. Example of a Q sorting distribution

Table 5. Condition of Instruction

| | Q study 1 | Q study 2 | Q study 3 | Q study 4 |
|---|---|---|---|---|
| Condition | Indicate the extent of which he/she agree or disagree with the following statements on transport mode choice | Which innovation would you like, or dislike, seeing in organic and low-input farming? | Sort landscape images from "least like" to "most like" according to your aesthetic point of view | 3 conditions of instruction<br>(a) Subject's self view<br>(b) Fishermen' interests<br>(c) Fisherman would likely sort |

### *2.1.5 Factor Analysis*

Once all of the participants had completed their Q sorts, the matrix of cross-correlations between all of the Q sorts is calculated and factor analysed to identify patterns across individuals [8]. Usually, most of the Q sorts produce less than three factors that can explain the majority of the variance. Determining the number of factors to extract is something empirical and depends on how the process of Q sorting was performed by the sorters and it can be also linked to many statistical and theoretical criteria [12]. One main rule for the determination of the significant factors was introduced by Brown [4]. According to this rule, a factor loading can be considered as significant at the 0.01 level ($p<0.01$) if it exceeds (1):

$$\pm 2.58 \times SE \qquad (1)$$

where the factor loading gives the extent to which a participant (Q sort) agrees or disagrees with any particular factor and the standard error (SE) is given by the expression (2):

$$SE = 1 \div \sqrt{n° \text{ items of } Q \text{ sample}} \qquad (2)$$

Another rule is based on the use of eigenvalues (EV). A factor's EV can be calculated by summing the squared loadings of all the Q sorts on that factor. According to this method, the number of factor to extract is indicated by the factors that have the EVs over 1.00.
The analysis is usually carried out with the specific software PQMethod. In each empirical Q study the centroid method and a varimax rotation were applied to extract factors.

## 2.2 Main Results

### *2.2.1 Q Study 1. Applying Q Methodology to Analyse Mobility Attitudes in Central Italy*

The factor solution accounted for 41 Q sorts and 57% of the total variance. Only one participant wasn't associated with any factor, see Table 6.

Table 6. Explained Variance for both factors

| | Factor 1 | Factor 2 |
|---|---|---|
| | Ecology Dream | Self Determined Focus |
| % expl. Var. | 33 | 24 |

Contrary to what we expected, everyday travel behaviour is not influenced by those statements dealing with self-expression [14]. On one hand, public transport was seen as unattractive, since several problems emerged during the focus groups. The main complaints were the low frequency of public transport, the absence of priority lanes, outlying districts poorly connected and, lastly, the lacks of night services. On the other hand, results indicated that public transport is not considered such as an expensive mode of transport or dirty and unsafe. Travel costs don't have a great importance for travellers, who probably would be willing to pay more, but for a more efficient public transport. Regarding transport policies, there's still much work to be done to improve public transport efficacy in order to make it more attractive. Little can be said about the introduction of more environmental travel norms. However, people recognized that improving public transport quality could be an important opportunity for improving those environmental travel solutions. Further reflections may derive from everyday experience. In Italy, for example, travellers tend to perceive the public transport as connected to negative and bad experiences. Public transport has been considered not as a valid alternative compared to the use of own cars. Probably as in Van Exel et al. [14], people can react more to normative solutions.

### *2.2.2 Q Study 2. An Application on Organic and Low-Input Dairy Supply-Chain: A Cross National Study*

The 99 Q sorts collected in each country were analysed producing two different Q study. For the first study, all Q sorts were grouped in three categories ("Consumers", "Farmers" and "Retailers & Processors") in order to extract factors separately for each supply-chain category. Then, a second order factor analysis was also applied to the primary factors extracted with the aim of reducing data and identifying the main sustainable farming innovations accepted. The second study grouped the 99 Q sorts by country (Belgium, Italy, Finland, and the United Kingdom) in order to reveal the relevant discourses for each country involved in the study. The first two factors were selected for each category and for each country involved, see Table 7.
Results identified only a limited number of distinctive viewpoints on the topic under investigation. Although the results of any Q study cannot be enlarged to the population, as they are only related directly to the individuals who participate, the wide range of viewpoints included in the present study provide a statistically rigorous picture of the possible different supply-chain perspectives in the broader population. There is considerable agreement across countries and supply-chain members as to the acceptability, or not in some cases, of innovations in low input and organic dairy farm management and supply-chain practices.

Table 7. Explained variance for both SC and Country Q studies

| | **SC analysis** | |
|---|---|---|
| | Factor 1 | Factor 2 |
| | Natural Animal Health and Welfare Purism | Quality Advocacy |
| Consumers | | |
| % expl. Var. | 27 | 20 |
| | Customer Focus | Farm Management |
| Farmers | | |
| % expl. Var. | 25 | 24 |
| | Low Input Forerun | Forage Advocacy |
| Retailers & Processors | | |
| % expl. Var. | 30 | 21 |
| | **Country analysis** | |
| | Factor 1 | Factor 2 |
| | Arcadian Dream | Short Supply-Chain Focus |
| Italy | | |
| % expl. Var. | 34 | 14 |
| | Free-Range Forage Support | Efficient Indoor Welfare Advocacy |
| Belgium | | |
| % expl. Var. | 29 | 25 |
| | Home-Grown Feed and Soil Management | Natural Animal Health and Welfare Purism |
| Finland | | |
| % expl. Var. | 30 | 24 |
| | Free-Range Ecological Foraging | Natural Animal Health and Welfare Advocacy |
| UK | | |
| % expl. Var. | 28 | 21 |

In all countries there were two main themes that dominated the innovations that were liked, these were innovations to improve animal welfare and innovations to improve feed and forage quality and reduce the use of purchased concentrate feed. The factors extracted identified synergies between various groups, showing that there is a consensus for non-GM solutions (among all of the respondent groups) and that importance is given to animal welfare, especially by the consumers and some of the farmers. The efficiency of the supply-chain and the better use of forage and feed appear to be an important concern, especially for farmers, retailers and processors, although forage quality is crucial also for a group of the consumers, as a means to improving milk quality.

These findings can contribute in the identification of pathways of changes and valuable opportunities for innovations to be introduced into the dairy system. The European dairy industry still accounts for 13% of the total food and drink turnover [16] but this is now facing many challenges. The abolition of milk quotas and full liberalisation will affect the dairy industry competitiveness in the near future. The dairy business is still a leader in food innovation (7.8% for total food industry [17]), although innovations in dairy products have become a necessity now, given the rapidly changing environment of which the agro-food industries of Europe are a part of. According to the results, setting an agenda for innovations in the dairy sector might not be a paramount task, given the relative consensus expressed

by the different stakeholders on low-input and sustainable dairy systems based on forage, soil biodiversity and animal welfare improvements. Further research is needed to confirm these findings in other countries and to fully investigate the antecedents of these attitudes in larger samples.

### *2.2.3 Q Study 3. An Assessment of the Visual Impact of Photovoltaic Systems in Rural and Urban Landscapes*

The three factor solution is presented in Table 8.

Table 8. Explained variance for each factor

| | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| | Innovative Design Advocates | Mimicry Effect Lovers | Farm Managers |
| % expl. Var. | 25 | 16 | 12 |

According to the results, the perception of the landscape visual impacts for the photovoltaic systems in Central Italy is characterised by a combination of two parallel requests: the preservation of the rural areas, in term of rural landscape aesthetic, with the maintenance of a regular development of the farming activities, and the attempt to reduce the PV visibility and impacts in urban settings. Utility and aesthetics of the PV plants are extensively and contemporary requested by all factors, albeit in different ways. Nevertheless different market segmentation is needed to satisfy different patterns in the acceptance of visual impacts of PV plants.

PV plants built to take advantages of the solar energy in rural buildings, as instruments for the exploitation of renewable resources, and to support the farm self-sufficiency are positively foreseen, but they should nor conflict with the presence of flora and fauna or determine a reduction of the cultivated areas [18]. But images of PV systems impacting the rural environment – i.e. forming an uninterrupted area of photovoltaic panels lying on the ground, installed on supports extremely close to each other, placed in the midst of a cultivated land or built to cover an agricultural area or on greenhouses – are consistently disliked.

During the recent years, the uncontrolled spread of PV plants in rural areas, due to the introduction of new sell-back tariffs, caused an alteration of the land use. The extensive introduction of the PV plants in agriculture failed in preserving those functions that the public considers as important, albeit secondary, to the farming activities. As a consequence, any radical transformation of the landscape, not only in the countryside, as well as PV plants images showing a concentration of PV system are strongly disliked by all factors. Conversely, generally appreciated are the images showing the modern applications of the PV systems in urban areas – those showing a sound barrier with PV along a highway, PV roof for keeping bicycles, PV curtain to cover a football field, a wooden coverage with integrated PV panels – or the industrial plants, the integrated systems on the industrial roofs. Designed as aesthetically integrated building components, the residential applications (factor 1) include awnings, wall products, spandrel panels, and glazings. Non-residential systems, designed as entire structures – e.g. bus shelters – include rooftops PV applications (factor 2), tiles, pebbles, standing seam products, and skylights. Both type of installations are widely appreciated for their ability to combine energy production with other functions of the building or non-building structure, in urban settings, and areas where land is both scarce and expensive. Finally, if the perspective of having PV plants grounded in the countryside represents the more traditional viewpoint but belongs to the past concept of PV installations, the im-

ages of PV integrated structure are the new trends: PV plants, integrated in tiles and becoming to all intents and purposes, part of the roof, are perceived as offering a lower visual impact while those included in the architectural characteristics of the building are the new developments for improving the architectural quality of the buildings.

### *2.2.4 Q Study 4. Evaluating the Visual Perceptions of the Mediterranean Deep-Sea Ecosystems*

For this Q study three conditions of instruction were used: a) sorting the photographs basing on the subject's self view (the above cited 1st condition); b) sorting them to favour fishermen' interests (the above cited 2nd condition); and c) sorting as a fisherman would likely sort, or in other words, verbally asking to personify in fisherman's shoes. This approach allowed to test the ability of participants of adapting their personal expression to other views associated to the second and the third conditions of instruction and to reduce the number of participants to 8 people, who generated 24 Q sorts. Three factors were extracted, see Table 9.

Table 9. Explained variance for each factor

| | Factor 1 | Factor 2 | Factor 3 |
|---|---|---|---|
| | Noah's Ark Followers | Ecosystem Functions Supporters | Coral Lovers |
| % expl. Var. | 47 | 11 | 5 |

Results demonstrated that only marine biologists were able to adapt their way of thinking regarding the Mediterranean deep-sea ecosystems. The different know-how of participants emerged directly through their sorts and it was captured inside the emerging factors. The three relevant discourses - Noah's Ark Followers, Ecosystem Functions Supporters and Coral Lovers - completely represented what was really important for people who participated to the sorting experiment.

In terms of species and habitats conservation the concept of "biodiversity" was mentioned many times d ring the post sort discussions as a priority aspect to preserve by both non-marine biologist and marine biologists. However, it is important to note that the word "biodiversity" was interpreted basically in two different ways: according to the non-biologists' view, "biodiversity" was uniquely associated to diversity of species belonged to 'animal kingdom'; by contrast, marine biologists associated this concept to the preservation of genetic, species and ecosystem diversity.

The Noah's Ark Followers group, in which can be noted a strong emphasis in saving those species typical of Mediterranean deep-sea ecosystems (in particular those important for the fishing industry), expressed the viewpoints of all non-biologists (independently from conditions) and of the marine biologists when they were asked to personify fishermen. It's interesting to note that, although non-marine biologists included in the P set had different education, they shared a common point of view of deep sea, suggesting that their background didn't allow them to discriminate each others on this unfamiliar matter. Moreover, their insufficient scientific knowledge on this environment likely caused the fact that they loaded into a single factor following different instructions. The possible explanation was that they expressed uniquely their viewpoint, being not able to adapt their way of thinking to the proposed conditions. On the contrary, the scientific background of marine biologists allowed them to express distinct opinions basing on different conditions and within the same condition.

According to this second factor, the priority was given to save different habitats, from the cold seeps to the rocky bottom and the coral reefs, which host peculiar communities, and

different kind of species, in terms of their role in the marine food web. Synthesising, this group of marine biologists wished to preserve those key elements, which would sustain the ecological health of deep-sea ecosystems in case a catastrophe destroyed the Mediterranean deep-sea ecosystems, namely habitats in which animals can live, feed and reproduce themselves and species from primary producers (e.g. chemosynthetic microorganisms) to top predators (e.g. sharks). As well as the Ecosystem Functions Supporters, the Coral Lovers group showed a very strong emphasis on the importance of the habitats. Related to the study of people's behaviour when they were asked to sort according to different conditions of instruction, is was observed that all participants shared a common viewpoint, grouping into the same factor, uniquely when they sorted as fishermen would likely do (3rd condition of instruction). This seemed to be because all respondents thought that the priority for a fisherman is preserving mainly the commercial species. On methodological side, the combination of images with Q Methodology represented an innovative approach for the study of subjective opinion about the deep-sea ecosystems. Similarly to what expected, non-biologists misunderstood the meaning of some showed images. Despite this, images were preferred to statements because they can provide to respondents a more direct representation of reality. This was thought to be particularly important for representing deep-sea elements, for which most of people even don't know the existence.

## 3 Conclusions

Q Methodology, combining both qualitative and quantitative research methods, is applied to reveal and give structure to individual subjectivity and it is especially recommended for those research topics investigating aspects of human behaviour [4].
This thesis outlines the potential benefits of Q Methodology by applying this approach within the frame of socio-economic and environmental research fields: transportation research, agricultural research and landscape assessment.
In the last decade Q Methodology, originally developed in psychology and political science, has been increasingly used in many other research fields where the psychometric knowledge has relevant implications. Q Methodology can be used to enrich data of a qualitative study and, at the same time, used as a 'guide' for a quantitative study. In this latter, once the opinions on a specific topic are identified with a Q analysis, it is possible to study if those opinions can be found in a larger population using quantitative surveys and standard variance analytic methods. Q Methodology more than other research methodologies, is not so easy to be applied, because it requires the researcher having developed enough experience in the methodology and not only in the topic – background – under investigation. Q researcher takes decisions at every step of a Q study (how to collect the concourse, how many statements and participants to include, how many factors to extract etc.) that can influence the results. In addition, having conducted several studies but also sharing problems and solutions between researchers can be of help to solve aspects that one researcher alone can overlook. This experience can only be acquired by performing a relevant number of Q studies. For this reason, the experience matured through the application of Q Methodology in four different studies allowed to provide methodological considerations about this approach and to produce this work.
As discussed, Q Methodology is characterized by five main steps: construction of the concourse, development of the *Q sample*, selection of the *P sample*, *Q sorting* process, and Factor extraction. Each step can offer opportunities and issues to be solved in order to obtain more reliable and valuable results. In the concourse construction, the use of experts, not directly involved in the study, to ensure "stimulus representativeness" [19] can reduce the da-

ta selection bias. In the deep-sea Q study, experts, who did not participate to the study, were also involved to refine the image selection in order to provide a good representation of Mediterranean deep-sea ecosystems for the respondents. In a verbal concourse, the bias can also be reduced, but not removed, by using people's natural statements. The use of a 'naturalistic' language facilitates the participants' task when performing the ranking process. In addition the use of a natural language more easily facilitate connections to subjective emotions or thoughts. For this reasons, it is important to convert impersonal language extracted from scientific journals, and other materials in "self-referent" expressions. In the dairy Q study where statements reported a description of innovations in the dairy supply-chain, the substitution of technical words in a more comprehensive language was particularly challenging. In this case, the use of pilot studies, including non-experts, and explanations of participants helped to simplify the confused statements.

The use non-verbal *stimuli* – images instead of statements – can be of help in specific situations. It is particularly useful because images are expected to elicit higher emotional reactions [20]. From the use of images – the first visual Q study applied to the investigation of people's perceptions of the landscape impacts for the photovoltaic systems in rural and urban landscapes, and the second on the evaluation of the subjective importance of the Mediterranean deep-sea ecosystem, images helped people to express their subjectivity during the Q sorting phase because of the complex and unfamiliar environment that this ecosystem represent. In both studies the use of images, better than words, favoured the comprehensions to participants of what they were asked to do; as a consequence, they completed their Q sort more easily, bridging the gap between experts and non-experts that took part to the sorting experiments.

Cross-country comparison is also an issue under investigation in Q Methodology. When several countries are involved, cultural and linguistic differences are to be taken into consideration in the concourse preparation. Having knowledge of the country differences on a specific topic is recommended in order to compose an exhaustive and complete concourse. For this reason, the concourse should be built by collecting materials from each country involved. To overcome the linguistic problems, statements are defined in one main language, usually English, and then translated in each country language of the other countries involved.

Other decisions are associated to the definition of the number of items that should be included in the Q sample. Deciding the number of items to be included is secondary respect to the variety of the Q sample [3]. If the Q sample is broadly representative, any existing viewpoints will be revealed after the analysis. The Q researcher has the delicate task of assuring a sufficient diversity in the final sample; in fact, if this is not covered the full range of structures behind the population could be missed. Several approaches can be used to create a set of items that can reflect the nature of the concourse, among those approaches the use of Fisher's experimental design principles can provide valuable data even if some attitude structures are missed.

Other methodological considerations can be taken for the participant sample or P set. P set is not created randomly from a population, what really matter, for Q Methodology, is ensuring as much variability in the composition of the P set. The use of a small P reduces costs and times, but at the same time, for a small participants sample maintaining an equal degree of variety among participants' opinions is not an easy task. A possible strategy is to include people with different backgrounds, interests, know-how and personality. For example, in the PV impact assessment the use of experts and non-experts helped to discover common patterns and produce different assessments on how and which objects are relevant.

The factor extraction is a crucial step in Q Methodology (as it is in conventional factor Analysis). Determining the ideal number of factors is a matter of interpretation. Unfortunately, there is not a scientific measure, although there are several statistical rules that can guide the determination of a 'good' solution. Q Methodology demonstrated that statistic supports the analysis, but the Q researcher has the delicate task to interpret and produce social narratives, relying on his/her familiarity with the subject and the existing scientific background, without imposing preconceived thought [4]. In order to favour the interpretations of factors, the Q researcher has to describe carefully participants' view and knowing more information as possible on them (i.e. participants' explanations, reactions, demographic data), applying the logic of abduction, so far discussed by Stephenson [4]. In relation to this aspect, some critics sustain that data can be influenced by the researcher's perspective. Contrary to other similar multivariate statistical methods – e.g. cluster analysis – Q Methodology imposes a certain 'commitment' of the researcher. For the Q researcher there is not a singular observable world to describe, and for this reason what emerges from a Q analysis is the manifest of the variety of thoughts on a particular matter of interest.
The reliability of Q Methodology results is often subject to critiques by non-Q practitioners. In the Q approach, reliability is associated to the concept of replicability, which means measuring the same response under the same condition each time with the same subjects. Limitations are attributed to the fact that there are no elements to reject the hypothesis that the some people could express different views on two separate times [21]. This critique can be disproved considering that Q sorting process is extremely subjective and the meaning impressed and expressed by a single person could change anytime. About the robustness of results, it is important to avoid those solutions in which specific factor is defined by only one person. In this case, the risk is to obtain a social perspective that doesn't differ from the individual perspective. While in some cases, if one factor is defined by a 'strategic' participant (i.e. expert), it is important to pay particular attention to the opinion of this subject and maintain this factor. Another controversial aspect is related to generalization. Q Methodology does not aim to produce generalization of the results to a wider population and there is no interest in estimating the percentage of people expressing a particular point of view [11]. In other words, Q Methodology does not aim at revealing the truth, it indeed concerns with the multiple truths of life. Trying to simplify, Q Methodology aims to identify the presence of certain views with very few participants. Q Methodology represents an important approach that can be preferred to other methodologies when subjective attitudes and opinions need to be investigated in very different research fields. As noted above, R methodologies, such as surveys or questionnaires, can fail when the purpose is investigating the subjective structure of beliefs, because they provide external measurement of people's behavior and have to be built on preconceived ideas and hypothesis to be tested.
The robustness of this methodology stems in its ability in revealing any perspectives and what stays beyond their structure is supported by the statistical approach of factor analysis. In applying Q Methodology to the socio-economic field, we gathered evidence that it is particular helpful when defining a problem or issue for further research, since it allows to consider all subjective viewpoint in a systematic and comprehensive manner. As a conclusion, we believe that Q Methodology should have greater diffusion in the field of economics, especially in complex, multi-faceted research situations like those where environmental economists are engaged. Q Methodology has high potential in management science too, since it could help decision-making in multi-actors, multi-disciplinary frameworks.

## References

[1] W. Stephenson. *Correlating persons instead of tests*. Character and Personality, 4,17-24, 1935.
[2] S. R. Brown. *A primer on Q Methodology*. Operant Subjectivity, 16, 91-138, 1993.
[3] B. McKeown, and D. Thomas. *Q Methodology*. Newbury Park, CA, Sage Publications, 1988.
[4] S. R. Brown. *Political subjectivity, applications of Q Methodology in political science*. New Haven, CT, Yale University Press, 1980.
[5] C. Spearman. *The abilities of man*. New York: Macmilian, 1927.
[6] R. Stainton Rogers. *Q Methodology*. In Smith, J.A., Harré, R., Van Langenhove, L. (eds). *Rethinking Methods in Psychology,* London, Sage, 178-192, 1995.
[7] W. Stephenson. *The foundations of psychometry: Four factor systems*. Psychometrika, 1(3), 195-209, 1936.
[8] S. Watts, and P. Stenner. *Doing Q methodological research: Theory, method and interpretation*. London, Sage, 2012.
[9] J. Previte, B. Pini, and F. Haslam-McKenzie. *Q Methodology and rural research*. Sociologia Ruralis, 47(2), 135-147, 2007.
[10] W. Stephenson. *The study of behaviour: Q technique and its methodology*. Chicago, University of Chicago Press, 1953.
[11] C. Kitzinger. *The Social Construction of Lesbianism*. Sage, Bristol, 1987.
[12] S. R. Brown. *The History and Principles of Q Methodology in Psychology and the Social Sciences*. Department of Political Science, Kent State University, Kent, OH, 1997.
[13] S. Watts, and P. Stenner. *Doing Q Methodology: Theory, method, and interpretation*. Qualitative Research in Psychology, 2 (1), 67-91, 2005.
[14] N. J. A.Van Exel, G. de Graaf, and P. Rietveld. *Getting from A to B: operant approaches to travel decision making*. Operant Subjectivity, 27, 194-216, 2004.
[15] G. Edwards-Jones. *Modelling farmer decision-making: concepts, progress and challenges*. Anim. Sci., 82, 783-790, 2006.
[16] CIAA. *Data & trends of the European food and drink industry*. Confederation of Food and Drink Industries of the EEC, Annual Report 2011, http://www.fooddrinkeurope.eu/uploads/publications_documents/1527_FoodDrinkEurope_AR11_12_FINAL_7.6.2012.pdf
[17] CIAA. *Data & trends of the European food and drink industry*. Confederation of Food and Drink Industries of the EEC. Annual report 2011, http://www.aijn.org/file.handler?f=juicynews%2FCIAA%20Data%20and%20Trends%202011-27-05.pdf
[18] R. Chiabrando, E., Fabrizio, and G. Garnero. *The territorial and landscape impacts of photovoltaic systems: Definition of impacts and assessment of the glare risk*. Renewable and Sustainable Energy Reviews, 13(9), 2441-2451, 2009.
[19] E. Brunswik. Perception and representative design of psychological experiments. Berkeley, University of California Press, 1947.
[20] S. R. Brown. *William Stephenson (1902-1989)*. American Psychologist, 46, 244, 1991.
[21] W. Stainton Rogers. *Explaining health and illness: An exploration of diversity*. Hemel Hempstead, Harvester Wheatsheaf, 1991.