A proposal for sorting a projects portfolio through the ELECTRE TRI method focused on the European strategy

Rosa Micale; Antonio Giallanza
Gabriella Li Puma; Giada La Scalia
Dipartimento di Ingegneria
Università degli Studi di Palermo, Italia

Abstract: In recent years, the partnerships between private companies and public organizations are becoming key elements for improving local development, territorial competitiveness, and delivering innovation. These collaborations are widely promoted by the European Framework Programme for Research and Innovation thanks to the provision of several instruments, such as Horizon 2020. In this context, competitiveness's improvement of the territory employing research and innovation actions is supported by the technological districts. In Sicily, the AgroBioPesca district has attempted a strategic action named "Call for ideas" in order to design its own roadmap for research and innovation in the agri-food sector. For this purpose, many proponents of public and/or private sectors presented several innovative project ideas referred to specific Technological Trajectories. This paper aims at providing an instrument able to select the most suitable project ideas in order to constitute the AgroBioPesca projects portfolio. To such an aim, the authors propose the application of the multiple criteria sorting method ELECTRE TRI considering criteria deduced by the Horizon 2020 guidelines and documents. The application of this methodology allows subdividing the project ideas received into project ideas to be rejected, reviewable, and eligible for funding. Moreover, to consider the uncertainty of the decision-makers' judgment, the authors propose a new version of the method in which the crisp judgment is converted into an interval. A sensitivity analysis has lastly been conducted to study the weaknesses of non-financiable projects.

Keywords: Project Management, Project Portfolio, Multi-Criteria Decision Making, ELECTRE TRI method, Sensitivity analysis.

1 INTRODUCTION

The EU Research and Innovation Programmes provides the main opportunities to overcome the competitivity gap among the different European local territories by means of the diffusion of Research and Innovation (R&I). In the last decades, the R&I financing programmes have favoured the development of the national economy by encouraging the partnership between public and private sectors. In specific, in 2014-2020 period, the Horizon 2020 (H2020) programme represents one of the most effective instruments in the European context ever. The H2020 programme attracts several investors by reducing the risk of private investments related to innovative projects characterized by a high-risk. Among the main actors, the technological districts have caught the funding opportunities provided by these programmes in order to obtain concrete results in key sectors with a high technological footprint. The districts are territorial aggregations of universities and public research organizations, enterprises and local governments, which cooperate for promoting territorial development by means of R&I's diffusion [1]. The technological districts significantly contribute to the advancement of Italian research and, consequently, they provide an impetus to the competitiveness and economy of the country [2]. In fact, research is the primary way to increase companies' business and, moreover, thanks to technological districts the participants are put on a network to share their know-how. A company that wants to innovate its products/processes can exploit the H2020 funding by means of these districts. This partnership supports the establishment of horizontal and vertical collaborations with other public organizations and/or private companies. In this way, it is possible to converge the objectives of aggregation and innovation in a research project in order to increase the competitiveness of the territory. The AgroBioPesca (TD) is the Sicilian technological district that operates for increasing the competitiveness of the regional territory in the key agri-food sector. In this context, TD thanks to a deeper analysis of European, national and regional strategies, has individuated some specific fields on which several project ideas could be developed. The latter, named Technological Trajectories (TTs), are defined coherently with H2020 documents [3] and customized to the peculiarities of the Sicilian business sectors (Strategia Regionale dell'Innovazione, SRI-3). The TTs identified are the following: Health and Wellness, Food Safety, Production processes for food quality, Sustainable and competitive food production, Blue growth: enhancing the potential of living aquatic resources, Use and valorization of by-products from agri-food production. With the purpose to increase local

territory's business, the TD organized some meetings between Sicilian main actors of public research organizations and companies of the agri-food sector. These sessions allowed the players to create networks and formulate project ideas to be proposed at EU funding calls of the 2014-2020 programming. In particular, the TD has collected several project ideas for each TT, which have been evaluated by a Technical and Scientific Committee (TSC) in order to select the best ones that will constitute the TD projects portfolio. The evaluation phase was conducted taking into account some criteria (Impact, Excellence, Quality & Efficiency) elaborated in accordance with the H2020's assessment guidelines and documents. The Impact criterion allows assessing the degree of sustainable socio-economic development for Sicilian territory. By making a thematic parallelism with the pillars of the H2020 programme, the authors consider two different segmentations of this criterion, "Industrial leadership" and "Society challenges". The Excellence criterion is essentially referred to as the assessment of the innovation degree provided by a project idea. Finally, the Quality & Efficiency criterion evaluates the skills of project idea proponents and the goodness of the partnership. The determination of criteria weights is executed coherently with the official guidelines of the H2020's assessment documents; instead the sub-criteria weights are calculated by considering pillars' budgets allocated by the European Commission (EC).

This paper proposes the application of a structured methodology that allows the TD classifying any received project ideas into three predefined classes: Rejected Project Ideas (RPI), Reviewable Project Ideas (RwPI) and Eligible Project Ideas (EPI). This structured approach will help the TD to focus on the more effective project ideas able to obtain the European founding. Hence, the main goal of this preliminary analysis is to find the most coherent project ideas with H2020 that represent the TD projects portfolio. The implemented methodology in this work, to sort the project ideas into predefined and ordered classes, is the multi-criteria ELECTRE TRI [4], belonging to ELECTRE family methods [5-6]. The method provides the definition of *ad-hoc* reference profiles that correspond to the classes' boundaries and with which every project idea is compared for the classification. The values chosen for these profiles are taken by the H2020's assessment documents, whereas indifference, preference and veto thresholds, necessary to implement the methodology, are defined by TD's board. ELECTRE TRI method has been applied in several problems and in different contexts. Siskos et al. (2007) [7] propose an integrated approach for the assessment of qualifications and skills of candidates. The candidates are classified into four pre-defined professional categories by means of the

ELECTRE TRI procedure by taking into account their professional experience, studies, and vocational training. These elements are collected through interviews and the analysis of curriculum vitae, certificates, etc. Sánchez-Lozano et al. (2014) [8] use the same method to identify and classify the best plots for installing photovoltaic solar farms in the Municipality of Torre Pacheco, in the southeast of Spain. Mota et al. (2012) [9] apply the ELECTRE TRI-C method to classify the project activities in three categories (the highest one contains the activities that require close monitoring, whereas the lowest one the activities in which supervision could be delegated to a subordinate). This decision model helps the project managers to focus on the main tasks of a project network during its life cycle. Silva et al. (2014) [10] evaluate the environmental sustainability of agricultural infrastructures of dairy farms in the Entre-Douro-e-Minho (EDM) Region by developing a system constituted by the integration between a GIS system and the MCDA ELECTRE TRI method. In Karakosta et al. (2009) [11] a list of suitable energy technologies proposed by Clean Development Mechanism (CDM) of the Kyoto Protocol for electricity generation was evaluated taking into account different objectives such as social impacts, GHC reduction, and environmental impacts. The authors classify these alternatives in high, low priority and not recommended using the ELECTRE TRI procedure. As said before, being at a preliminary stage, the TD projects portfolio is dynamic, and hence a method for which the insertion of a new alternative does not have an impact on the classification of the others is appropriate. In this sense, the ELETRE TRI is suitable because the alternatives (project ideas) are sorted by making a comparison with predefined reference profiles. Moreover, to take into account the uncertainty of the decision-makers' judgment, the authors propose a new version of the method, the Interval ELECTRE TRI (ELECTRE TRI-I), able to transform the crisp judgment into an interval. Finally, a sensitivity analysis on project ideas that have passed from RwPI class to EPI class, by comparing the classification obtained by means of the classical ELECTRE TRI with the interval one, was implemented. This analysis has been carried out to understand the proposals' features that should be improved.

2 CALL FOR IDEAS

In 2015, TD undertook a new plan named "Call for ideas" with the aim of developing its own roadmap of projects. For this reason, the TD has collected several innovative ideas in the agri-food sector in order to respond to the medium and long term social challenges defined at national and European level in the 2014-2020 strategy. Firstly, TD created a template

containing the description of the TTs that it provided to public and private players. Each player developed its project ideas coherently to these TTs. In the second phase, TD has defined the evaluation criteria by means of a careful analysis of European, national, and regional programming documents, further elaborated in more detail in Section 2.2.

2.1 TECHNOLOGICAL TRAJECTORIES

The TD has conducted an analysis aimed at identifying the most promising areas on which the companies should develop their research activities. In other words, the main goal was to identify the scientific-technological areas able to increase the competitiveness of the territory concretely. TT's identification was carried out considering the different business sectors of the agri-food system of the Sicilian territory. Based to H2020, Piano Operativo Nazionale Ricerca e Innovazione 2014-2020 (PON R&I 2014-2020) and Piano Operativo Regionale 2014-2020 (POR 2014-2020), the main TTs on which TD has focused its attention have been identified. In particular, it was decided to consider six TTs on which developing the Roadmap for Research and Innovation of TD described below.

TT_1: Health and Wellness – H2020's Framework Programme for R&I fully supports the promotion of health, prevention of diseases and improvement of the physical and mental wellness of the population. Nutrition is one of the factors that most affect people's life quality and psycho-physical conditions [12]. Some literature contributions [13-14] show a correlation between different lifestyle aspects and physical/mental health. These studies demonstrate a relevant improvement of health as a consequence of small modifications in lifestyle. In the last decade, social and economic mutation due to globalization has led to significant changes in the eating habits and behaviors of the society (e.g. eating away from home, the need for personalized diets that take into account tastes and preferences expressed by consumers, e-commerce, etc.) [15]. These bad habits are the main causes of an increase of chronic diseases related to nutrition (e.g. obesity, cardiovascular diseases, etc.) [16]. According to the World Health Organisation (WHO), a healthy lifestyle is achievable through a balanced and healthy diet. Following a healthy diet throughout the life course can help to prevent malnutrition, cardiovascular diseases, and cancers, to reduce body weight, to keep cholesterol and blood pressure under control. Consequently, it would be appropriate to give consumers the possibility to buy healthy and appealing food products in order to follow a balanced diet. Based on

international, national and local strategies the TD decides to implement and develop strategic ideas in this area in order to satisfy the growing demand of healthy food.

TT2: Food Safety – In the last decade the EU population has focused its attention on food safety concepts. The EC has recognized this need adopting a food safety policy aimed to guarantee the humans, animals, and plants at every stage of production. The traceability, risk management, and the information sharing provide transparent procedures and structured systems able to increase customers' satisfaction and their perception of foods quality. The EU has adopted the global "from farm to fork" intervention strategy, which focuses on the concept of traceability of both incoming and outgoing food flows [17], with the aim to assure a high level of food safety. In this sense, the EU has established rules and mandatory controls to guarantee the safety of the agri-food supply chain in all stages of the production, processing, and distribution. These actions aim at ensuring that plant and animal products are healthy, that food and feed are safe, of high quality, properly labeled and complied with stringent EU standards [18]. Although it is recognized that the public health and consumer protection is correlated with the concept of food safety [19] the private investment to ensure the safety of the food supply is still often limited and not well planned in many developing countries. The TD has identified this TT to respond to the local companies' needs to satisfy the European regulations and to implement appropriate strategies related to food safety.

TT3: Production processes for food quality **–** Nowadays, the greater production of healthy, safe and sustainable food has led the companies in the agro-food sector and the scientific research to study and to employ innovative technologies, processes and methods able to maintain food's organoleptic and nutritional characteristics. The challenge faced by this TT is to develop advanced systems and methods that ensure the quality of food and extend its shelf life. Moreover, this trajectory aims to develop advanced technologies able to produce foods that satisfy the taste and personal preferences of each consumer (tailor-made food) while preserving their quality and sensory characteristics. There is a wide contribution of the scientific literature on these topics, in Bilek and Turantaş (2013) [20] an overview of the applications of ultrasound technology as an alternative method for microbial inactivation in fruit and vegetable is described. Several studies show the benefits obtained in terms of extension of the shelf life and preservation of the organoleptic characteristics of the perishable products through the use of innovative materials and techniques for packaging and/or the storage at controlled temperatures [21-22]. Techniques such as pulsed light, high pressure, pulsed electric and magnetic fields,

irradiation and natural antimicrobial ingredients are being used or investigated to eliminate undesirable microorganisms of the food products [23-24-25]. Finally, the most important technologies to produce high-quality concentrated omega-3 products, such as supercritical fluid chromatography (SFC) and molecular distillation (MD), are reported in De Meester et al. (2013) [26].

TT_4: Sustainable and competitive food production – By the middle of this century, the world's population is estimated to reach 9.8 billion [27]. In order to respond to the expected demand of a growing population, food production must increase to meet future needs. The major effort is hence to produce more food trying to preserve the natural resources (e.g. water and soil) necessary to support this required growth. This increase in food production will involve climate change, water scarcity, soil degradation and biodiversity destruction [28]. The concepts of controls, management, productivity and sustainability of the natural resources have gained increasing attention. In recent years these aspects have been promoted and implemented by means of the precision agriculture technologies. The application of the appropriate treatments in the right place at the right time allow obtaining a low-input, high-efficiency, sustainable food production [29]. The greatest challenge faced by this TT is to develop and introduce new food production methods able both to minimize environmental impact and to guarantee the production of food in the future. Therefore, to achieve these results, the food sector should increase the productivity of the existing crop, to make farming an economic development opportunity for people living in rural areas, to preserve the environment by means of the reduction of the pollutant emissions and the use of natural resources such as water and soil, whereas producing healthy and safe foodstuffs [30].

TT_5: Blue growth: enhancing the potential of living aquatic resources – The Blue Growth is the long-term strategy that emphasizes the concept of sustainable management of the marine and maritime resources. This strategy is based on the premise that the preservation of the marine environment and its biodiversity is crucial to human existence. The EC recognizes the importance of the oceans and seas as a potential driver of economic growth. For this reason, it focuses its attention on issues such as the protection of the marine environment, the prevention of pollution and the degradation of marine ecosystems, and the need for sustainable management of marine resources. In line with this strategy, the H2020 programme, in fact, supports research activities in order to promote the management and the exploitation of natural resources. The growth of the marine and maritime sectors could lead in fact substantial damages

to marine ecosystems [31] and their management is hence of crucial importance. In order to guarantee blue growth, the EC has planned interventions aimed at increasing the productivity and sustainability of the main economic areas which involve the use of marine and maritime resources. Several initiatives, such as H2020, EMFF (European Maritime and Fisheries Fund), Marine knowledge 2020, etc., are provided by the EC in order to satisfy the blue growth strategy. This strategy has focused attention on five specific priority sectors (coastal and maritime tourism; ocean energy; seabed mining; aquaculture and blue biotechnology) because they have great potential for innovation and growth of the territory. Moreover, their integrated management is a central aspect of the blue growth strategy. The importance of the synergic interaction between the key existing sectors (fisheries, transportation, and offshore hydrocarbon) and emerging sectors (aquaculture, tourism, and seabed mining) is also emphasized in the study of Kingler et al. (2018) [32]. Finally, the TD's strategic choice to include the "blue growth" among its TTs is supported by the data extrapolated from the SRI-3 that highlight a great interest in this field. This strategy identifies in fact about 10,000 companies related to the sea economy with a prevalence of the ichthyic sector and of the aquaculture.

TT_6: Use and valorization of by-products from agri-food production – The reduction and/or the reusing of the waste deriving by the agri-food productions is nowadays a challenge that needs to be tackled with urgency. The problem of managing these wastes can be converted into an opportunity, i.e. the waste becomes a resource. Their reduction and valorization are strongly promoted topics by institutions and legislative bodies and widely discussed by the scientific community [33]. The significant amounts of waste deriving from the agro-industrial activities could potentially be employed for the production of energy or the recovery of high value-added substances. These opportunities could generate advantages in terms of waste disposal and environmental impact reduction. The problem of the waste reduction and the recovery of functional substances that can be used to enrich food is faced in La Scalia et al. (2017) [34]. Moreover, the need for economic and sustainable development leads toward the use of alternative energy sources in substitution of fossil fuels. The study of Chisti (2007) [35] shows that the microalgae are a renewable source to obtain biodiesel. This latter with the biodiesel deriving from oil crops, waste cooking oil, and animal fat can represent an effective solution able to satisfy the global demand for transport fuels. Then, an important societal and scientific challenge that this TT intends to address is the valorization of the by-products and the reduction

of waste from the agro-food supply chain. This could be achievable through the employment of advanced technologies and innovative processes able to transform these wastes into products with high value, energy, etc.

2.2 CRITERIA DEFINITION

After a detailed review of the H2020 guidelines and documents related to different types of actions (such as IA - Innovation Action, RIA - Research and Innovation Action, etc.) a set of evaluation criteria have been chosen. Specifically, in this paper, in line with the criteria adopted by H2020 during the grant proposals evaluation, the following criteria were selected: "Impact", "Excellence" and "Quality & Efficiency". The evaluation criteria are described below. ***Criterion 1: Impact*** – A proposal is more likely to receive funding from the H2020 programme if it is not only well written from a scientific point of view but also includes a series of actions that maximize the impact of the results. The impact measures the financial, social, technical, economical, sustainable and environmental benefits of the proposal. The proposal should be able to enhance the capacity for innovation, create new market opportunities, improve the competitiveness and growth of the companies, respond to climate and environmental challenges or produce important benefits for the society. The impact criterion is considered in order to evaluate if a project idea can produce effects on citizens who are the beneficiaries of the investment programmes outputs. Moreover, the aspect related to the implementation of actions aimed at increasing the competitiveness of the companies, underlined in the documents provided by the H2020 guidelines for the criterion impact, has been taken into account. These documents also highlight the importance that the submitted projects would have in relation to sustainability issues. The study of H2020 programme has shown that the concepts of innovation and competitiveness reflect the notions set out in Industrial Leadership's pillar whose purpose is to create industrial leadership in a competitive framework that makes Europe a more attractive place to invest in R&I. The "Industrial Leadership" pillar will be implemented through:

- actions to support the development of the key enabling technologies (KETs) in strategic areas of innovation such as Information and Communication Technology, nanotechnology, advanced materials, biotechnology, advanced production systems. The new and breakthrough technologies contribute to boosting competitiveness, creating jobs and supporting growth;

- access to risk capital financing;
- support for companies' innovation.

On the other hand, the concept of sustainable growth is addressed in "Societal challenges" pillar. The "Societal challenges" priority responds to the key needs identified by the Europe 2020 strategy and deals with issues of major socio-economic impact. The nature and complexity of these challenges call for a scientific and technological effort that requires increasingly multidisciplinary research geared towards long-term sustainable solutions. The priority areas of intervention of this pillar are:

- health, demographic change, and wellness;
- food security, sustainable agriculture, marine, and maritime research and bio-economy;
- safe, clean and efficient energy.

Based on these considerations the Impact criterion has been split into the two sub-criteria $C_{1.1}$ Industrial Leadership and $C_{1.2}$ Societal challenges.

Criterion 2: Excellence – The H2020 aims at increasing the quality of the research by supporting the implementation of projects with a high level of scientific excellence. The proposals must show innovative solutions in comparison with existing ones, achievable and pertinent objectives and a clear exposition of the topics. Based on these considerations the criterion excellence was hence considered. In particular, this criterion takes into account the degree of innovation of the project idea and the risks associated with its possible placing on the market. In detail, Excellence evaluates:

- the innovation potential of the proposal beyond the state of the art (e.g. novel products/processes/services, approaches, and concepts);
- S.M.A.R.T. (specific, measurable, available, relevant, time-bound) objectives;
- soundness and the clarity of the concepts;
- the technical feasibility of the proposal.

Criterion 3: Quality & efficiency – The criterion Quality & Efficiency considers the technical/business experience of the team comprising their managing capacity. It evaluates the availability of the resources required (personnel, facilities, network, etc.) to develop the project activities and it verifies that all the participants have a valid role and adequate capabilities to fulfill that role. The roles and the responsibilities of each member involved in the project should be clearly defined considering their skills. The criterion considers the complementarity of the participants and the capacity of the team to integrate the necessary expertise.

2.3 THE METHODOLOGICAL APPROACH

2.3.1 ELECTRE TRI

ELECTRE TRI is a Multi-Criteria Decision Method for sorting problems that assign the alternatives $a_m \in A = \{a_1, a_2, \ldots, a_m\}$, to pre-defined and ordered classes $C_h \in Z = \{1, 2, \ldots, h, \ldots, z\}$. This method involves the evaluation of every alternative on several qualitative and/or quantitative criteria g_j where $j \in \{1, 2, \ldots, J\}$. Differently, to the other ELECTRE methods, which dealt with problems of choice and/or ranking, the ELECTRE TRI assigns the alternatives to classes C_h that must be *a priori* defined by means of references profile p_h.

The set of the classes are ordered by the worst to the best one and each one is characterized by a lower p_{h-1} and an upper profile p_h [36], hence p_h is the upper limit of class C_h and the lower limit of C_{h+1}, as reported in **Figure 1**.

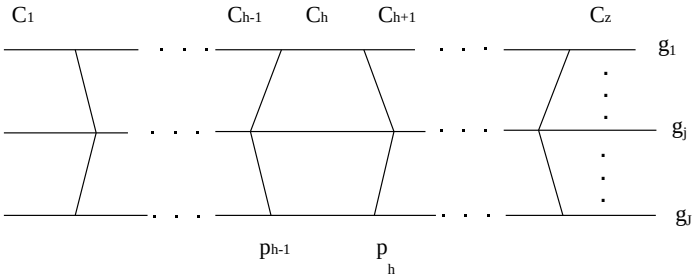

Figure 1: Definition of classes using reference profiles

The ELECTRE TRI method is composed by the following two phases:

1. the definition of outranking relations S between alternatives and reference profiles (i.e. a_m S p_h) and vice versa (i.e. p_h S a_m);
2. the assignment of each alternative a_m to a predefined class.

In particular, the meaning of relation $a_m S p_h$ is "a_m is at least good as p_h" on a majority of criteria (concordance principle) whereas the minority of criteria does not support this statement (discordance principle) [37]. The outranking relation a_m S p_h (and vice versa) is obtained developing the following steps:

1. the calculation of the partial concordance index $c_j (a_m, p_h) \in [0; 1]$ for a specific criterion j (and vice versa). This index represents the degree of acceptability of the statement "a_m is at least as good as p_h";
2. the calculation of the comprehensive concordance index $c^*(a_m, p_h) \in [0;1]$ (and vice versa) that represents the contribution of all criteria to the statement "a_m is at least as good as p_h" evaluated as the weighted sum of the partial concordance indices;

3. the calculation of the discordance index calculated for each criterion $d_j\ (a_m, p_h) \in [0;1]$ (and vice versa) that considers the opposition to the statement "a_m is at least as good as p_h" regarding the criterion j;
4. the calculation of the credibility index $\sigma(a_m, p_h) \in [0;1]$ (and vice versa) by combining the comprehensive concordance index and the discordance indices.

These values are obtained using the formula provided by the ELECTRE III method [38]. Finally the fuzzy outranking relations are converted into crisp ones by means of a parameter named λ - cutting level ($\lambda \in [0,1]$) that represents the smallest value of the credibility index compatible with the assertion $a_m S\, p_h$. The comparison between $\sigma(a_m, p_h)$ (and vice versa) and λ- *cut* allows to determine the preference relation between a_m and p_h. In particular, let $\succ$, I and R denote respectively the preference, indifference and incomparability relation, the alternative a_m and the profile p_h may be correlated with the following binary relations:

- $a_m\ I\ p_h$ iff $a_m\ S\ p_h$ and $p_h\ S\ a_m$,
- $a_m \succ p_h$ iff $a_m\ S\ p_h$ and not $p_h\ S\ a_m$,
- $p_h \succ a_m$ iff $p_h\ S\ a_m$ and not $a_m\ S\ p_h$,
- $a_m\ R\ p_h$ iff not $a_m\ S\ p_h$ and not $p_h\ S\ a_m$.

These binary relations are depicted in **Figure 2**:

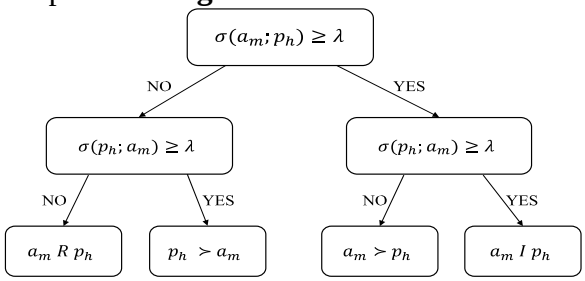

Figure2: Representation of the binary relations

The second phase of the method consists in the exploitation of the outranking relations with the aim of assigning an alternative to a defined class. The method suggests two assignment procedures: the optimistic and the pessimistic. Specifically, the rules' generalization mentioned above is the following:

- *Pessimistic rule* – By comparing the alternative a_m with the best reference profile p_i $(i = z, z\text{-}1, \ldots, 1)$, this procedure assigns a_m to the highest class C_{h+1} for which the first outranking relation ($a_m\ S\ p_h$) occurs.

- *Optimistic rule* – By comparing the alternative a_m with the worst reference profile p_i *(i=1, 2,…, z),* the optimistic procedure assigns a_m to the lower class C_h such that the first relation $(p_h \succ a_m)$ occurs.

A difference exists between the two sorting procedures only when an alternative is incomparable to one or several profiles; in such a case the pessimistic assignment rule assigns the alternative to a lower class than the optimistic one [39]. In this paper, the ELECRE TRI method is applied for sorting collected project ideas of each scenario (TT) and, for each of these, the optimistic classifications have been implemented. According to Roy and Bouyssou (1993) [38], the λ-cut value is belonging to the range [0.5; 1].

2.3.2 ELECTRE TRI-I

In this section, the ELECTRE TRI method is extended to include the uncertainty due to the high degree of subjectivity of the decision-makers' judgments. For this purpose, the authors propose an Interval ELECTRE TRI (ELECTRE TRI-I) method version transforming the crisp DM judgment into an interval. In particular, each interval is obtained by subtracting and adding a fixed value φ to the generic crisp score a_{mj}. Hence, the generic judgment can be extended to the interval $[Lb_{mj}; Ub_{mj}]$, where $Lb_{mj} = (a_{mj} - \varphi)$ and $Ub_{mj} = (a_{mj} + \varphi)$ that represent its lower and upper bound respectively. Let x and y the lower and upper bounds of the evaluation scales of the judgments for each criterion j respectively, the ELECTRE TRI-I procedure considers the constraints reported in equation 1 to obtain an interval of numbers in the same range $[x; y]$.

$$\begin{cases} \text{If } Lb_{mj} < \text{x} \implies Lb_{mj} = \text{x} \\ \text{If } Ub_{mj} > \text{y} \implies Ub_{mj} = \text{y} \end{cases} \quad (1)$$

Like the classic version of the ELECTRE TRI method, the new approach in composed by two steps: the construction of the outranking relations and the classification procedure. The following exposition is relative to criteria with increasing preferences versus, but obviously the formula has to be adapted if the preferences versus is decreasing. In the first step, while the classic approach considers the differences between p_{hj} and a_{mj} (and vice versa) to obtain the outranking relations $a_m \, S \, p_h$ (and vice versa), in this approach, the differences have to be computed between p_{hj} and all values of the interval $[Lb_{mj;} \, Ub_{mj}]$ (and vice versa). These differences have to be compared with the indifference, preference and veto thresholds of each criterion j (I_j, S_j and V_j). In particular, the ELECTRE TRI-I approach considers only the differences between p_{hj} and the lower and upper bound of the interval. In fact, if the

indifference, preference and veto conditions evaluated both for the lower and the upper bound are respected, they will be also verified for all the points of the interval. For this reason, the following differences have to be defined in order to evaluate the $a_m\, S\, p_h$ conditions:

$$\begin{cases} Y_{mj} = p_{hj} - Lb_{mj} \\ Z_{mj} = p_{hj} - Ub_{mj} \end{cases} \quad (2)$$

Whereas in order to evaluated the $p_h\, S\, a_m$ conditions:

$$\begin{cases} R_{mj} = Lb_{mj} - p_{hj} \\ V_{mj} = Ub_{mj} - p_{hj} \end{cases} \quad (3)$$

whose difference are equal to T_{mj}, namely the range width $[Lb_{mj}, Ub_{mj}]$.

For simplicity only, the considerations related to $a_m\, S\, p_h$ relations are reported below; in order to define $p_h\, S\, a_m$ outranking relations the equations (2) have to be replaced by the equations (3). The necessary steps to implement the new algorithm are described below.

Step 1: construction of the marginal concordance indices $c_j'(a_m, p_h)\ \forall j \in J$

- If Y_{mj} is lower than or equal to zero, the marginal concordance indices $c_j'(a_m, p_h)$ are equal to 1, i.e.:

$$If\ Y_{mj} \leq 0 => c_j'(a_m, p_h) = 1 \quad (4)$$

- If $Y_{mj} \leq I_j$, the marginal concordance indices $c_j'(a_m, p_h) = 1$ whereas if $Z_{mj} \geq S_j$ the marginal concordance indices $c_j'(a_m, p_h) = 0$.
- In the ELECTRE TRI-I the values of the marginal concordance indices depend on the position of the interval T_{mj} with respect to the threshold values. Several cases may occur, both Z_{mj} and Y_{mj} between I_j and S_j, or threshold values I_j or S_j (or both) could be between T_{mj}. **Figure 3** shows the most general case that could occur:

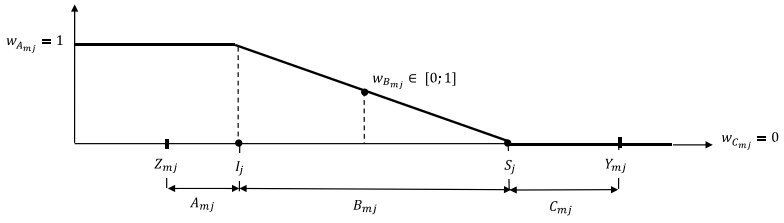

Figure 3: Marginal concordance indices

Let A_{mj}, B_{mj}, C_{mj} be all possible intervals defined as follow:

- $A_{mj} = \{\min(Z_{mj}; I_j)\ ;\ \min(I_j; Y_{mj})\}$, that falling below I_j
- $B_{mj} = \{\max(I_j; Z_{mj})\ ;\ \min(Y_{mj}; S_j)\}$, that is between I_j and S_j

- $C_{mj} = \{\max(S_j; Z_{mj})\ ;\ \max(S_j; Y_{mj})\}$, that is greater than S_j. and being T_{mj} the sum of the intervals defined above.

The method evaluates the marginal concordance indices as follows:

$$c_j'(a_m, p_h) = w_{A_{mj}} \cdot \frac{A_{mj}}{T_{mj}} + w_{B_{mj}} \cdot \frac{B_{mj}}{T_{mj}} + w_{C_{mj}} \cdot \frac{C_{mj}}{T_{mj}} \quad (5)$$

A specific parameter is associated with each of these ranges (named w_{Amj}, w_{Bmj}, w_{Cmj} respectively) that represent the degrees of their individual contribution compared with the marginal concordance index of the whole interval. It is crucial to point out how these parameters are computed. Each of these values corresponds to the concordance index resulting from the application of the ELECTRE III algorithm in correspondence of the midpoint of the related interval. Consequently, to the assertions above:

1. $w_{Amj} = 1$;
2. $w_{B_{mj}} = \frac{S_j - \left\{Z_{mj} + \left[\frac{\min(Y_{mj}; S_j) - \max(I_j; Z_{mj})}{2}\right]\right\}}{S_j - I_j}$, obtained as linear interpolation between the points *(I_j, 1)* and *(S_j, 0)* in the midpoint of the interval,
3. $w_{Cmj} = 0$

Step 2: evaluation of the comprehensive concordance index $c'^*(a_m, p_h)$ that is calculated as the weighted sum of the partial concordance indices:

$$c'^*(a_m, p_h) = \sum_{j=1}^{J} \hat{w_j} \cdot c_j'(a_m, p_h)$$

Where $\hat{w_j}$ is the weight-importance coefficient related to criterion j.

Step 3: computation of the marginal discordance indices $d_j'(a_m, p_h)\ \forall j \in J$ that takes into account the following statements:

- If no veto threshold V_j exists, marginal discordance index $d_j'(a_m, p_h)$ is equal to zero;
- If $c_j'(a_m, p_h) \neq 0\ \forall j \in J$ the corresponding value of the marginal discordance index $d_j'(a_m, p_h)$ is null;
- If $Y_{mj} \leq S_j$, the marginal concordance indices $d_j'(a_m, p_h) = 0$ whereas if $Z_{mj} \geq V_j$ the marginal concordance indices $d_j'(a_m, p_h) = 1$

- The way for calculating marginal discordance indices in the ELECTRE TRI-I refers to the same considerations valid for the marginal concordance indices. **Figure 4** shows the most general case that could occur:

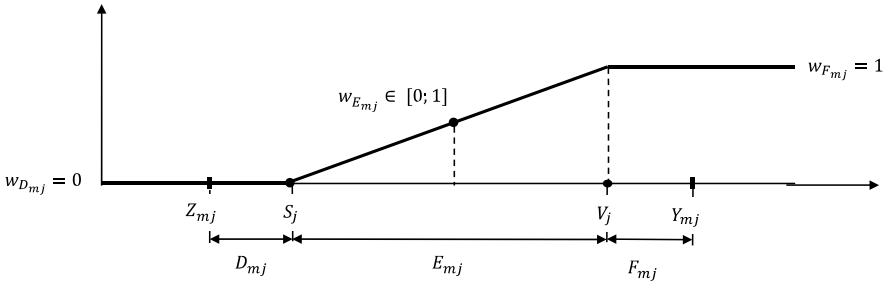

Figure 4: Marginal discordances indices

Therefore, let D_{mj}, E_{mj}, F_{mj} be all possible intervals defined as follow:

- $D_{mj} = \{\min(Z_{mj;}; S_j)\ ; \min(S_j; Y_{mj})\}$, the generic interval below S_j;
- $E_{mj} = \{\max(S_j; Z_{mj})\ ; \min\ (Y_{mj}; V_j)\}$, between S_j and V_j;
- $F_{mj} = \{\max(V_j; Z_{mj})\ ; \max(\ V_j; Y_{mj})\}$, that is greater than V_j.

and being T_{mj} the sum of the intervals defined above $T_{mj} = D_{mj} + E_{mj} + F_{mj}$.

If $c_j'(a_m, p_h) = 0$ one of the following cases may occur depending on the position of the Z_{mj} and Y_{mj} respect to the threshold values S_j and V_j. Similar to marginal concordance indices, the ELECTRE TRI-I method evaluate the marginal discordance indices as follows:

$$d_j'(a_m, p_h) = w_{D_{mj}} \cdot \frac{D_{mj}}{Z_{mj}} + w_{E_{mj}} \cdot \frac{E_{mj}}{Z_{mj}} + w_{F_{mj}} \cdot \frac{F_{mj}}{Z_{mj}}$$

where w_{Dmj}, w_{Emj}, w_{Fmj} are obtained as follow:

1. $w_{Dmj} = 0$,
2. $w_{E_{mj}} = \frac{\left\{Z_{mj} + \left[\frac{\min(Y_{mj};V_j) - \max(S_j;Z_{mj})}{2}\right]\right\} - S_j}{V_j - S_j}$, computed as a linear interpolation between the points *(S_j, 0)* and *(V_j, 1)* in the midpoint of the interval,
3. $w_{Fmj} = 1$.

Analogously to the classic ELECTRE TRI method, the outranking relation is obtained developing the *credibility index of outranking* $\sigma(a_m, p_h) \in [0,1]$ (and vice versa) as provided by the ELECTRE III algorithm and the sorting of each project alternative a_m to a predefined class is carried out by means of the optimistic rules.

3 CASE STUDY

Through the strategic plan "Call for ideas" the TD has received a total number of proposals equal to 180, each one belonging to a specific TT. The total number of proposals received by the TD for every TT is shown in **figure 5**:

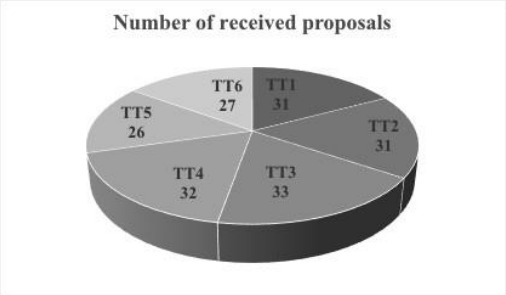

Figure 5: Number of received proposals

As reported in **figure 5** the received project ideas are well distributed, this confirms the appropriateness of the choice of the TTs identified by the TD. These TTs well reflect in fact the peculiarity of the agro-food sector of the Sicilian territory. TD's TSC has evaluated the proposals coherently with criteria and sub-criteria explained in section 2.2. According to H2020's assessment documents, the weights of 0.50, 0.25 and 0.25 to the macro criteria Impact (C_1), Excellence (C_2), Quality & Efficiency (C_3) respectively have been considered. The procedure by which the weights of sub-criteria $C_{1.1}$ and $C_{1.2}$ have been determined considers the budget assigned to "Industrial Leadership" and "Societal Challenges" pillars by H2020's programme (16,466 and 28,629.6 million € respectively). In particular, these weights have been found by considering the percentage of budget addressed to each of them compared to the whole budget of both pillars and subsequently normalized to the weight of the macro criterion C_1.
The weights of criteria and sub-criteria are reported in **Table 1**:

Criteria	Weights
$C_{1.1}$	0.183
$C_{1.2}$	0.317
C_2	0.250
C_3	0.250

Table 1: Weights of criteria and sub-criteria

As said before, the main goal of this paper is to assign project ideas into three distinct classes: Rejected Project Ideas (RPI), Reviewable Project Ideas (RwPI) and Eligible Project Ideas (EPI). The implementation of the ELECTRE TRI classic as the ELECTRE TRI-I requires *a priori* definition of classes, i.e. reference profiles that delimit the boundary between the adjacent

classes. The design of these latter has been achieved by means of the evaluation scale (**Table 2**) provided by H2020's assessment documents.

Score	Qualitative judgment	Interpretation
0	Rejected	The proposal fails to address the criterion or cannot be assessed due to missing or incomplete information
1	Poor	The criterion is inadequately addressed, or there are serious inherent weaknesses
2	Fair	The proposal broadly addresses the criterion, but there are significant weaknesses
3	Good	The proposal addresses the criterion well, but a number of shortcomings are present
4	Very Good	The proposal addresses the criterion very well, but a small number of shortcomings are present
5	Excellent	The proposal successfully addresses all relevant aspects of the criterion

Table 2: H2020 evaluation scale

For the purpose of this study, the evaluation scale has been linearly normalized in the interval *[0,1]*. According to the authors' opinion, a project should be evaluated with a qualitative judgment of at least "Fair" on all criteria in order not to be discarded; otherwise, if the project idea obtains a score of "Good" (or more) on each criterion, coherently with H2020, it could be considered eligible for funding. By following statements above, the reference profiles have been identified at the "Fair" and "Good" levels. The normalized assessment scale in **Table 2**, with the addition of the intermediate levels that symbolize the situations of compromise, has been also provided to the TSC of TD in order to evaluate the project ideas. Hence, the decision maker has evaluated a project idea with a score in the interval [0;1] in steps of 0.1. The indifference, preference and veto thresholds, defined by TD's board, are 0.1, 0.2 and 0.4 respectively, whereas the λ - a cutting level considered is 0.55.

4 RESULTS AND DISCUSSIONS

4.1 SORTING PROCEDURE

The first step consisted of the clusterization of the received project ideas through the application of the classic ELECTRE TRI method. The rule selected to assign the project ideas to the predefined class was the optimistic one because it is suitable when actions that are interesting or that have exceptional qualities have to be encouraged. The case study analyzed is related to TD's initial stage of evaluating proposals and a higher number of project ideas could increase the social impact of the "Call for ideas" strategic plan from a political point of view. This consideration confirms that the optimistic procedure, which tends to oversize the best class

(EPI), is effectively the most appropriate. Let $P_{i,j}$ be the project idea j belonging to the TT_i, **Table 3** reports the results of the classification methodology.

TTs	RPI	RwPI	EPI
TT_1	$P_{1.2}$, $P_{1.5}$, $P_{1.15}$, $P_{1.18}$, $P_{1.20}$, $P_{1.21}$, $P_{1.22}$, $P_{1.23}$, $P_{1.26}$, $P_{1.27}$, $P_{1.29}$	$P_{1.7}$, $P_{1.9}$, $P_{1.10}$, $P_{1.12}$, $P_{1.13}$, $P_{1.14}$, $P_{1.16}$, $P_{1.19}$, $P_{1.24}$, $P_{1.30}$	$P_{1.1}$, $P_{1.3}$, $P_{1.4}$, $P_{1.6}$, $P_{1.8}$, $P_{1.11}$, $P_{1.17}$, $P_{1.25}$, $P_{1.28}$, $P_{1.31}$
TT_2	$P_{2.5}$, $P_{2.18}$, $P_{2.24}$, $P_{2.27}$, $P_{2.30}$	$P_{2.3}$, $P_{2.4}$, $P_{2.8}$, $P_{2.10}$, $P_{2.11}$, $P_{2.14}$, $P_{2.15}$, $P_{2.17}$, $P_{2.20}$, $P_{2.23}$, $P_{2.28}$	$P_{2.1}$, $P_{2.2}$, $P_{2.6}$, $P_{2.7}$, $P_{2.9}$, $P_{2.12}$, $P_{2.13}$, $P_{2.16}$, $P_{2.19}$, $P_{2.21}$, $P_{2.22}$, $P_{2.25}$, $P_{2.26}$, $P_{2.29}$, $P_{2.31}$
TT_3	$P_{3.3}$, $P_{3.10}$, $P_{3.16}$, $P_{3.30}$, $P_{3.33}$	$P_{3.5}$, $P_{3.6}$, $P_{3.18}$, $P_{3.20}$, $P_{3.21}$, $P_{3.22}$, $P_{3.24}$, $P_{3.26}$, $P_{3.27}$	$P_{3.1}$, $P_{3.2}$, $P_{3.4}$, $P_{3.7}$, $P_{3.8}$, $P_{3.9}$, $P_{3.11}$, $P_{3.12}$, $P_{3.13}$, $P_{3.14}$, $P_{3.15}$, $P_{3.17}$, $P_{3.19}$, $P_{3.23}$, $P_{3.25}$, $P_{3.28}$, $P_{3.29}$, $P_{3.31}$, $P_{3.32}$
TT_4	$P_{4.7}$, $P_{4.12}$, $P_{4.13}$, $P_{4.15}$, $P_{4.25}$, $P_{4.29}$, $P_{4.32}$	$P_{4.1}$, $P_{4.9}$, $P_{4.22}$, $P_{4.23}$, $P_{4.24}$, $P_{4.26}$, $P_{4.28}$, $P_{4.31}$	$P_{4.2}$, $P_{4.3}$, $P_{4.4}$, $P_{4.5}$, $P_{4.6}$, $P_{4.8}$, $P_{4.10}$, $P_{4.11}$, $P_{4.14}$, $P_{4.16}$, $P_{4.17}$, $P_{4.18}$, $P_{4.19}$, $P_{4.20}$, $P_{4.21}$, $P_{4.27}$, $P_{4.30}$
TT_5	$P_{5.3}$, $P_{5.4}$, $P_{5.14}$, $P_{5.15}$, $P_{5.17}$, $P_{5.20}$	$P_{5.1}$, $P_{5.2}$, $P_{5.6}$, $P_{5.12}$, $P_{5.13}$, $P_{5.21}$, $P_{5.22}$, $P_{5.26}$	$P_{5.5}$, $P_{5.7}$, $P_{5.8}$, $P_{5.9}$, $P_{5.10}$, $P_{5.11}$, $P_{5.16}$, $P_{5.18}$, $P_{5.19}$, $P_{5.23}$, $P_{5.24}$, $P_{5.25}$
TT_6	$P_{6.1}$, $P_{6.4}$, $P_{6.5}$, $P_{6.6}$, $P_{6.8}$, $P_{6.12}$, $P_{6.16}$, $P_{6.19}$, $P_{6.22}$, $P_{6.24}$	$P_{6.2}$, $P_{6.9}$, $P_{6.20}$, $P_{6.23}$, $P_{6.26}$	$P_{6.3}$, $P_{6.7}$, $P_{6.10}$, $P_{6.11}$, $P_{6.13}$, $P_{6.14}$, $P_{6.15}$, $P_{6.17}$, $P_{6.18}$, $P_{6.21}$, $P_{6.25}$, $P_{6.27}$

Table 3: Sorting of classic ELECTRE TRI method

Table 3 shows that among the 180 proposals the 24.44%, 28.33% and 47.23% belong to RPI, RwPI and EPI classes respectively. Finally, **Table 4** details the percentage values of the project ideas belonging to the three defined classes. This Table illustrates that, for all TTs, the EPI class is the most numerous, with the exception of TT_1 for which the number of rejected project ideas is greater than those eligible for funding.

TTs	RPI	RwPI	EPI
TT_1	35.48%	32.26%	32.26%
TT_2	16.13%	35.48%	48.39%
TT_3	15.15%	27.27%	57.58%
TT_4	21.88%	25.00%	53.12%
TT_5	23.08%	30.77%	46.15%
TT_6	37.04%	18.52%	44.44%

Table 4: Percentage of project ideas in the classes

4.2 SORTING BY MEANS OF ELECTRE TRI-I

The classification of project ideas, thanks to the application of the new interval methodology described in Section 2.3.2, has been carried out for all the received project ideas belonging to each TT. In particular, the crisp score of each proposal has been converted into an interval by adding and subtracting from the crisp judgment the value $\varphi = 0.1$. Analogously to the classic

application of the method, the optimistic rule has been applied. **Table 5** shows the results of sorting project ideas by utilizing the Interval optimistic ELECTRE TRI method version.

TTs	RPI	RwPI	EPI
TT_1	$P_{1.2}$, $P_{1.5}$, $P_{1.14}$, $P_{1.18}$, $P_{1.20}$, $P_{1.22}$, $P_{1.24}$, $P_{1.29}$, $P_{1.30}$	$P_{1.9}$, $P_{1.11}$, $P_{1.13}$, $P_{1.15}$, $P_{1.16}$, $P_{1.21}$, $P_{1.23}$, $P_{1.26}$, $P_{1.27}$, $P_{1.28}$	$P_{1.1}$, $P_{1.3}$, $P_{1.4}$, $P_{1.6}$, $P_{1.7}$, $P_{1.8}$, $P_{1.10}$, $P_{1.12}$, $P_{1.17}$, $P_{1.19}$, $P_{1.25}$, $P_{1.31}$
TT_2	$P_{2.3}$, $P_{2.4}$, $P_{2.5}$, $P_{2.8}$, $P_{2.11}$, $P_{2.18}$, $P_{2.24}$, $P_{2.27}$, $P_{2.30}$	$P_{2.6}$, $P_{2.10}$, $P_{2.14}$, $P_{2.16}$, $P_{2.17}$, $P_{2.20}$, $P_{2.21}$, $P_{2.23}$, $P_{2.28}$	$P_{2.1}$, $P_{2.2}$, $P_{2.7}$, $P_{2.9}$, $P_{2.12}$, $P_{2.13}$, $P_{2.15}$, $P_{2.19}$, $P_{2.22}$, $P_{2.25}$, $P_{2.26}$, $P_{2.29}$, $P_{2.31}$
TT_3	$P_{3.3}$, $P_{3.10}$, $P_{3.16}$, $P_{3.18}$, $P_{3.21}$, $P_{3.24}$, $P_{3.27}$, $P_{3.30}$, $P_{3.33}$	$P_{3.5}$, $P_{3.6}$, $P_{3.8}$, $P_{3.20}$, $P_{3.22}$, $P_{3.26}$	$P_{3.1}$, $P_{3.2}$, $P_{3.4}$, $P_{3.7}$, $P_{3.9}$, $P_{3.11}$, $P_{3.12}$, $P_{3.13}$, $P_{3.14}$, $P_{3.15}$, $P_{3.17}$, $P_{3.19}$, $P_{3.23}$, $P_{3.25}$, $P_{3.28}$, $P_{3.29}$, $P_{3.31}$, $P_{3.32}$
TT_4	$P_{4.1}$, $P_{4.7}$, $P_{4.9}$, $P_{4.12}$, $P_{4.13}$, $P_{4.15}$, $P_{4.22}$, $P_{4.24}$, $P_{4.25}$, $P_{4.26}$, $P_{4.28}$, $P_{4.29}$, $P_{4.32}$	$P_{4.8}$, $P_{4.11}$, $P_{4.14}$, $P_{4.18}$, $P_{4.20}$, $P_{4.23}$, $P_{4.31}$	$P_{4.2}$, $P_{4.3}$, $P_{4.4}$, $P_{4.5}$, $P_{4.6}$, $P_{4.10}$, $P_{4.16}$, $P_{4.17}$, $P_{4.19}$, $P_{4.21}$, $P_{4.27}$, $P_{4.30}$
TT_5	$P_{5.3}$, $P_{5.12}$, $P_{5.15}$, $P_{5.17}$	$P_{5.1}$, $P_{5.2}$, $P_{5.4}$, $P_{5.6}$, $P_{5.11}$, $P_{5.13}$, $P_{5.14}$, $P_{5.16}$, $P_{5.20}$, $P_{5.21}$, $P_{5.22}$, $P_{5.23}$, $P_{5.24}$	$P_{5.5}$, $P_{5.7}$, $P_{5.8}$, $P_{5.9}$, $P_{5.10}$, $P_{5.18}$, $P_{5.19}$, $P_{5.25}$, $P_{5.26}$
TT_6	$P_{6.1}$, $P_{6.2}$, $P_{6.5}$, $P_{6.6}$, $P_{6.8}$, $P_{6.12}$, $P_{6.16}$, $P_{6.19}$, $P_{6.20}$, $P_{6.22}$, $P_{6.23}$	$P_{6.3}$, $P_{6.4}$, $P_{6.17}$, $P_{6.18}$, $P_{6.24}$, $P_{6.26}$	$P_{6.7}$, $P_{6.9}$, $P_{6.10}$, $P_{6.11}$, $P_{6.13}$, $P_{6.14}$, $P_{6.15}$, $P_{6.21}$, $P_{6.25}$, $P_{6.27}$

Table 5: Sorting of ELECTRE TRI-I method

Table 5 shows that among the 180 proposals the 30.56%, 28.33% and 41.11% belong to RPI, RwPI and EPI classes respectively. Moreover, **Table 6** shows the percentage values of the project ideas belonging to the defined classes. It can be observed that for the trajectories TT_1, TT_2 and TT_3 the EPI class is the most numerous of the others. For the TT_4 and TT_6 trajectories, the number of proposals not eligible for funding is the highest.

TTs	RPI	RwPI	EPI
TT_1	29.03%	32.26%	38.71%
TT_2	29.03%	29.03%	41.94%
TT_3	27.27%	18.18%	55.55%
TT_4	40.63%	21.87%	37.50%
TT_5	15.38%	50.00%	34.62%
TT_6	40.74%	22.22%	37.04%

Table 6: Percentage of projects ideas in the classes

It is important to highlight the novelties that the new method ELECTRE TRI-I has brought to the results. In **Table 7** the comparison between the results of the two procedures is reported in terms of the total number of project ideas belonging to the corresponding class. The execution of the same methodology by using intervals rather than crisp data has led to a different sorting due to the subjectivity associated with the experts' judgments. In all trajectories, except for TT_1, the number of project ideas in the EPI class has decreased while the number of proposals rejected or requiring further analysis/changes has increased.

TTs	:PI	RwPI	:PI

	classic	interval	classic	interval	classic	interval
TT_1	11	9	10	10	10	12
TT_2	5	9	11	9	15	13
TT_3	5	9	9	6	19	18
TT_4	7	13	8	7	17	12
TT_5	6	4	8	13	12	9
TT_6	10	11	5	6	12	10

Table 7: Comparison of the results of the two methods

4.3 SENSITIVITY ANALYSIS

As already mentioned, the application of the two methods has led to different configurations in the three classes in all the defined TTs. Since the purpose of the study is to determine the best projects eligible for funding, the authors decided to conduct a sensitivity analysis on project ideas that, bypassing from the classical method to the ELECTRE TRI-I, have moved from RwPI class to EPI one. This additional study has been conducted in order to understand which features of project ideas should be improved for the second phase of evaluation conduced of the TD. The proposals that have been analyzed in the sensitivity analysis are shown in **Table 8**.

TTs	from RwPI to EPI class
TT_1	$P_{1.7}$, $P_{1.10}$, $P_{1.12}$, $P_{1.19}$
TT_2	$P_{2.15}$
TT_3	/
TT_4	/
TT_5	$P_{5.26}$
TT_6	$P_{6.9}$

Table 8: Analyzed proposals

The sensitivity analysis has been carried out on each project idea reported in **Table 8**, by improving its evaluation by 0.1 on the criterion with the highest weight ($C_{1.2}$) and repeating the sorting by means of the classical ELECTRE TRI method. The aim of this analysis was to verify if a project idea has improved its class bypassing to EPI. The proposals that have not changed their class have been submitted to another sensitivity analysis, by improving their score by a further 0.1. The results of the sensitivity analysis are reported in **Table 9**. This shows that a small change in the project idea score related to the criterion $C_{1.2}$, in 43% of cases, causes a change in the class to which it belongs already from the first analysis. In particular, only three proposals have undergone a change of class on a total of seven project proposals. These are: $P_{1.10}$, $P_{1.19}$ and $P_{5.26}$.

TTs	Proposals	Original class	Class with $C_{1.2}$ improved score by 0.1	Class with $C_{1.2}$improved score by 0.2
TT_1	$P_{1.7}$	RwPI	RwPI EPI	RwPI
	$P_{1.10}$	RwPI	RwPI	--
	$P_{1.12}$	RwPI		RwPI
	$P_{1.19}$	RwPI	EPI	--
TT_2	$P_{2.15}$	RwPI	RwPI	RwPI
TT_5	$P_{5.26}$	RwPI	EPI	---
TT_6	$P_{6.9}$	RwPI	RwPI	RwPI

Table 9: Results of sensitivity analysis

5 CONCLUSION

The key driver of the European strategy in order to encourage the growth of the territory and to create jobs for the citizens is technological innovation. In the last decade, it was clear that the achievement of these objectives can not be obtained individually from the public and private actors. The necessity to create a network in order to share know-how is, hence, of fundamental importance. In this context, the technological districts represent the opportunity to satisfy these necessities making a significant contribution to raising the level of technological innovation. With such an aim the TD has acted in the Sicilian agri-food sector. In particular, the TD has pursued this strategy undertaking the "call for ideas" action. This study deals with the evaluation and classification of project ideas received by TD in six different TTs. In this paper, to satisfy this goal, the ELECTRE TRI sorting method, that allows assigning proposals into ordered and defined classes on the basis of different evaluation criteria, was used. The identified criteria (Impact, Excellence and Quality & Efficiency) have been chosen, together with their weights, by means of a careful study of the H2020's guidelines and documents; in particular, the Impact criterion has been split up into two sub-criteria that refer to the bases of H2020's pillars Industrial Leadership and Societal Challenges. The boundary of the three identified classes ("Rejected project ideas", "Reviewable project ideas" and "Eligible project ideas") has been specified by two reference profiles whose values have been defined by means of the evaluation scale provided by H2020's assessment documents. The score of each project idea and ELECTRE TRI thresholds values have been decided by TD's TSC and TD board respectively. By considering all the TTs, the TD has collected 180 project ideas, the results obtained show that the 47.23%, 28.33% and 24.44% of these proposals belong to the EPI, RwPI and RPI class respectively. In a second phase to take into account the uncertainty of the decision-makers' judgment, the authors have applied a new version of the method transforming

the crisp judgment into an interval. The execution of the same methodology by using interval rather than crisp data has allowed more details in the classification and, in particular, a greater discretization of the evaluations. Finally, the authors have decided to perform a sensitivity analysis on project ideas that, bypassing from the ELECTRE TRI classic method to the ELECTRE TRI-I, moved toward the eligible for funding class (EPI). The decision maker's quantitative judgment of single proposals on criterion $C_{1.2}$ has been increased of 0.1 in order to verify whether, in respect of the score's increase, the class change has occurred. From this first analysis, we have seen that 43% of the projects have gone immediately to the EPI class. The proposals, whose class did not change, have been subjected to a further sensitivity analysis, with which their score on criterion $C_{1.2}$ has been increased of 0.2. Despite this further improvement, these were classified in RwPI class.

Further studies in this field could concern the definition of several Key Performance Indicators that are able to provide the decision-maker with clear indications about the proposals' features to be improved in order to make them suitable for funding.

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