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ARTICLES

EXPLORING THE COMBINATION OF HOLISTIC EVALUATION AND ELICITATION BY DECOMPOSITION IN FITRADEOFF: PRIORITIZING CULTURAL TOURISM PRODUCTS IN POLAND

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ABSTRACT. This paper presents the problem of the prioritization of cultural tourism products (CTP) in Czeladź, one of the post-industrial towns in southern Poland. For the decision analysis, the new flexibility features of the FITradeoff multiple criteria method will be explored. In particular, this paper focuses on the combination of two preference modeling paradigms in the decision process: elicitation by decomposition, in the consequences space; and holistic evaluation, in the alternatives space. The FITradeoff method is a multiple criteria decision method for preferences elicitation in additive aggregation models, that works based on partial information about the decision maker's preferences. The new decision process with the FITradeoff Decision Support System (DSS) will be explored and discussed in detail. The advantages of combination of two types of preference modeling are highlighted, with the possibility of shortening the decision problem with holistic judgments made based on graphical visualizations, saving time and effort from decision makers.

Keywords: cultural tourism products prioritization, FITradeoff method, preference modeling.

1 INTRODUCTION

Cultural tourism is considered one of the largest, constantly growing tourism markets, which has become an attractive form of gaining revenue for cities and regions (Liu, 2014). It increases their popularity and competitiveness and, what is important for a long-term perspective, encourages people to invest and/or live there. On the other hand, it also allows them to preserve the culture. United Nations World Tourism Organisation (UNWTO) defines cultural tourism as a type of tourism activity in which the visitor's essential motivation is to learn, discover, experience,

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and consume the tangible and intangible cultural attractions/products in a tourism destination (UNWTO, 2019). It may touch a number of elements of culture; therefore, many substreams of cultural tourism have emerged, such as heritage tourism, arts tourism, gastronomic tourism, and film tourism (Richards, 2018). They may attract different types of tourists, depending on the scope of the attraction offered and the tourists' experience and awareness (Sina Mousavi et al., 2016). They may be 'general' tourists, for whom visiting places and attractions is only a hobby and a way of spending their free time, or 'specialized' tourists, who visit the town or region purposely and repeatedly in search of a broad cultural understanding of it. No matter which types of cultural tourism and cultural tourists are considered, a key important factor that may stimulate cultural tourism is, according to its definition, the attractions/products it may offer. Therefore when trying to raise new cultural activity in the region, the local authorities should pay special attention to adequate planning or designing of new products (or series of products) that would build an interesting and comprehensive portfolio of attractions for the tourists.

Compared to the other types of products and services, cultural tourism products (CTP) have different characteristics, and there is a need to understand their specificity. CTPs may be single homogeneous products (mono-product), but they may also consist of many different products (multi-product) (Żabiński, 2009, 2015). Each multi-product may also consist of mono- and multi-products, each having a different form and type. The examples of CTPs types or categories are the following (Stokes, 2008; Yu & Xu, 2019): product-thing or product-material good (guidebook, map) or product-service or set of services (thematic tourist guide, hotel, and catering services, themed rallies, trips). Note also that some of these products may be offered in various forms, namely: as real products (traditional, material ones), multimedia (as digital photos, films, or animations), virtual (on the web or as software applications), or mixed/hybrid. Designing a new CTP requires selecting some mono-products that should be included in the multi-product and considering some organizational, technical, infrastructural, and financial issues. Some attractions may belong to different owners (local government authorities, different entities, institutions), which makes the problem under consideration a group decision-making problem with various stakeholders. All these parties usually will have different goals and priorities regarding the form and scope of the product; hence the evaluation of CTP may require using many private and public criteria. Even if the problem is considered at the level of local authorities, all these criteria need to be taken into consideration. Hence, a non-trivial problem arises: selecting the best CTP that may be designed out of the preselected mono-products that would satisfy all the considered criteria most efficiently. Naturally, the multiple criteria decision aiding (MCDA) tools are considered to be used to solve it.

There are studies (Chou, Hsu, Chen, 2008; Williams, Penrose, Hawkes, 1998; Wong, Fung, 2016) that concern the use of various MCDM/MCDA methods to solve complex decision-making problems in the field of tourism or cultural tourism. Each decision problem has its own specificity and context. The thematic diversity of cultural tourism also implies the selection of appropriate decision-making and support methods, as well as an adequate adjustment of these methods to the entire characteristics of the previously structured problem.

In this context, this paper aims to present the problem of the prioritization of cultural tourism products in one of the post-industrial towns in southern Poland, Czeladź. For guiding the decision analysis, the FITradeoff (Flexible and Interactive Tradeoff) multiple criteria method will be applied. The recently incorporated flexibility features of the FITradeoff method (De Almeida et al, 2021) will be illustrated: In particular, the combination of two preference modeling paradigms in the decision process - elicitation by decomposition and holistic evaluation – are explored and discussed in detail. The FITradeoff method is a multiple criteria decision method for eliciting criteria scaling constants in additive aggregation models that works based on partial information about the decision maker's preferences (De Almeida et al., 2016). Different decision problematics can be addressed with the FITradeoff method: choice (De Almeida et al., 2016; De Almeida et al., 2021); ranking (Frej et al., 2019; De Almeida et al., 2021); sorting (Kang et al., 2020) and portfolio with benefit-to-cost ratio analysis (Frej et al., 2021).

The FITradeoff method has been widely applied for solving several practical decision problems in the most varied areas, such as the energy sector (Fossile et al., 2020; Kang et al., 2018; de Macedo et al., 2018); selection of agricultural technology packages (Carrillo et al., 2018); supplier selection (Frej et al., 2017); selection of strategic information systems (Gusmão & Medeiros, 2016); healthcare facility location (Dell'Ovo et al., 2017); water resources management (Monte et al., 2019); selection of scheduling rules (Pergher et al., 2020); textile sector (Rodrigues et al., 2020); information technology outsourcing decisions (Poleto et al., 2020); selection of triage systems in the healthcare sector (Camilo et al., 2020), among others.

All these applications, however, focus on the FITradeoff process based on elicitation by decomposition without exploring the recently developed feature of holistic evaluations. In this sense, the present work aims to address the problem of selection of Cultural Tourism Products (CTP) in Poland presented by Czekajski et al (2021) differently, showing how the decision process with FITradeoff can be carried out by combining those two paradigms in preference modeling and how the incorporation of the holistic evaluation can improve the decision process. Possibilities of exploring the graphical visualization tools presented in the new version of the FITradeoff decision support systems will be explored, and insights on the use of holistic evaluation will be discussed. In order to better structure the process, the whole application will be conducted based on a decision framework to address the problem, following an adaptation of the framework proposed by De Almeida et al (2015).

This work is structured as follows. Section 2 presents a brief overview of the FITradeoff method and its new flexibility features. Section 3 describes the post-industrial CTP decision problem and its context. In Section 4, a decision framework is presented to solve the problem based on the FITradeoff method: Section 4.1. describes the preliminary phase with basic elements of the decision problem, and Section 4.2. shows the whole preference modeling phase conducted with the FITradeoff Decision Support System. Section 5 discusses the results obtained by the model, and in Section 6 some conclusions are presented.

2 FITRADEOFF METHOD

The FITradeoff method (Flexible and Interactive Tradeoff) (De Almeida et al., 2016; De Almeida et al., 2021) was developed for solving multiple criteria decision problems within the scope of the Multiattribute Value Theory (MAVT – Keeney & Raiffa, 1976). In additive aggregation models, establishing the values of criteria scaling constants (or weights) is not an easy task due to the actual meaning of these parameters, which cannot be considered as level of importance, but a scaling factor is also involved (Belton & Stewart, 2002; Keeney & Raiffa, 1976). The FITradeoff method carries out the whole structure of the classical tradeoff procedure but improves its applicability for the decision makers with easier elicitation questions and several flexibility features.

The FITradeoff method combines in its structure two preference modeling paradigms: elicitation by decomposition and holistic evaluation (De Almeida et al., 2021). The elicitation by decomposition follows the preferences elicitation process of the classical tradeoff procedure, in which the decision maker compares elements within the consequences space, considering tradeoffs amongst criteria. However, instead of setting up indifference points, they answer a series of questions regarding strict preference, which is more straightforward. The elicitation by decomposition is conducted based on an interactive question-answering process with the decision maker. After each question is answered, the information given by the DM is incorporated into a linear programming model that runs searching for potentially optimal alternatives, in the case of choice problematic (De Almeida et al., 2016) or for dominance relations between alternatives, in the case of the ranking problematic (Frej et al., 2019). The holistic evaluation consists of comparisons of elements within the alternatives space, in which the DM can select the best alternative within a subset or eliminate one of them (De Almeida et al., 2021). For the ranking problematic, the DM can define dominance relations between alternatives in a direct manner. The holistic evaluation in the FITradeoff method is aided by graphical visualization tools provided by the FITradeoff decision support system, through which the DM can visualize the alternatives in a comparative manner, considering their performance in each criterion. The holistic evaluation is a valuable tool to improve the decision process, and it can be useful in two different manners (De Almeida et al., 2021): i) to provide additional information to the model, which is the case that the information obtained from the holistic evaluation enters within the mathematical model of the FITradeoff method, in order to update the current space of weights; or ii) to finalize the decision process, when it is possible to reach a final solution for the decision problem with the holistic judgment made by the DM.

The FITradeoff method is operated by means of an interactive decision support system (DSS), which is freely available for users at http://www.cdsid.org.br/fitradeoff. In the FITradeoff DSS process, one of the main flexibility features is the possibility to alternate between these two types of preference modeling so that the DM provides information in the most convenient way for him at that point in the process. The presence of an analyst to guide the decision process is critical here (De Almeida et al., 2021). The combination of the two preference modeling paradigms

improves the decision process in the sense that it can be accelerated in some cases, as will be further illustrated in Section 4.

3 POST-INDUSTRIAL HERITAGE IN CZELADŹ

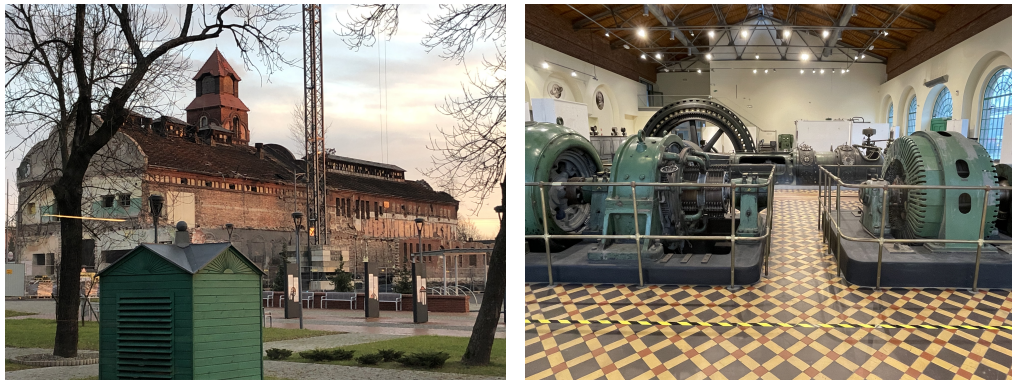
Czeladź is a small town located in the region called Dkabrowa Basin in southern Poland. Together with neighboring Upper Silesia, it was one of the most industrialized regions of the country in the past. Czeladź also had its share in the industrial development of this region. From the 19th century, Czeladź was an important center of hard coal mining with two mines: the "Saturn" mine and the "Czeladź" mine. Factory owners from Łódź (the center of the textile industry in Poland from the second half of the XIX century), including the ones of the largest textile factories, became the owners of the "Saturn" mine in 1899 and made significant contributions to the city's development, both in the period up to the outbreak of World War I and in the interwar period. The mining industry developed strongly in Czeladź, which focused on not only the construction of hard coal mining plants but also the social and living infrastructure around two mines. More than 25 years have passed since the liquidation of the last coal mine in Czeladź, and the remaining industrial infrastructure (buildings, mining shafts, machines, devices, etc.), public utility buildings, residential estates create a solid basis of post-industrial remains to become tourist attractions – post-industrial tourism products.

The starting point for assessing the potential and possibilities of creating a new comprehensive CTP promoting post-industrial heritage is the identification of this heritage through the analysis and review of archival materials and historical literature.

Detailed studies of the sources and publications mentioned above resulted in recognition of various existing elements of the post-industrial heritage of two former hard coal mines: "Saturn" and "Ernest-Michał" (later mine "Czeladź", and then "Czeladź-Milowice"). The great variety of the identified heritage can be included in a general classification, namely:

- Type I: Post-industrial facilities (buildings, architectural objects) of the former coal mine "Saturn".
- Type II: Housing estate – workers' and clerks' housing.
- Type III: Housing estate – public utility buildings.
- Type IV: Housing estate – management's buildings.
- Type V: Machine and equipment infrastructure.
- Type VI: Parks, gardens and estate greenery.
- Type VII: Sports and playing fields and other sports facilities.
- Type VIII: Church and parish.
- Type IX: Monuments.

The identified instances of such types of rich heritage are shown in Table 1, and two selected are shown in Fig. 1.



(a) **(b)**

Figure 1 – The examples of post-industrial heritage in Czeladź: (a) The Gathering Hall of the former coal mine "Saturn", (b) Inside the central power plant of former coal mine "Saturn".

Table 1 – Examples of the identified existing post-industrial heritage in Czeladź.

Type of post-industrial heritage	Examples of post-industrial heritage
Facilities (buildings, architectural objects) of the former coal mine "Saturn"	1. Gathering hall: a) guild hall b) bathhouse c) cloakroom d) administration e) meeting room 2. Electrical workshop and transformer room – currently The Center for Social Services and Local Activity 3. Machine workshop 4. Power plant (central power plant building, compressors room and switching station) 5. Boiler house building (boiler room) – with two chimneys 6. Shaft No. 1: a) overhang building with the hoisting tower of shaft No. 1 b) the engine room of shaft No. 1 7. Shaft No. 2: a) the superstructure of shaft No. 2 b) the engine room of shaft No. 2 8. Fire brigade building
Housing estate – workers' and clerks' housing	1."Old Settlement" ("Stara Kolonia") housing estate 2. "New Settlement" ("Nowa Kolonia") housing estate 3. Caretaker houses at Francuska St. 4. Workers' houses at Tadeusz Kościuszko St. 5. Chief Mechanic's House at the intersection of streets: Władysław Sikorski St. and Tadeusz Kościuszko St. 6. Clerical tenement houses at the intersection of streets: Władysław Sikorski St. and Adam Mickiewicz St. 7. "Old Settlement" ("Stara Kolonia") housing estate at 3 Kwietnia St. 8. The building is called "House for four stores" ("Dom dla czterech sklepów") at Zwycikestwa St. 9. Residential houses at Nowpogońska St. 10. Buildings called "White Houses" ("Białe Domy") at Nowopogońska St. 11. Complex of multi-family houses "Betony" at Nowopogońska St. 12. Villa at 3 Kwietnia St. 13. House of the Governing Council Delegate of The Coal Mines Nameless Society "Czelad'z"

Type of post-industrial heritage	Examples of post-industrial heritage
Housing estate – public utility buildings	1. Former clerks' clubs 2. Buildings of the former schools 3. Former orphanage for children 4. Former teachers' house 5. Former workers' hotel 6. Former dining room for mine workers – currently "Mine of Culture" (municipal cultural institution)
Housing estate – management buildings	1. Mine management building of the "Saturn" coal mine 2. Villa of the "Saturn" coal mine director 3. Former Main Office of the "Czeladź" coal mine
Machine and equipment infrastructure	1. Machines and devices in the former power plant: a) Power system – "Wanda" power generator (reversible compressor) b) Compressor by Belliss & Morcom c) Power system – Generator set I d) Power system – Generator set II e) Power system – Backup power generator – Brown Boveri converter f) Control and measurement desk g) Gantry h) Compressor control cabinet by Belliss & Morcom i) Signalling board j) Switchgear units, exciter units k) Control and measurement cabinets l) Movable links for switchgear m) Piping parts n) Other ancillary infrastructure 2. Machines and devices in former mechanical workshops 3. Machines and devices in buildings above the shafts 4. Machines and devices in the shafts 5. Machines and devices in the engine rooms of shaft
Parks, gardens and estate greenery	1. The Jordan Park 2. The "Prochownia" Park
Sports and playing fields and other sports facilities	1. Sports fields in the "Old Settlement" ("Stara Kolonia") housing estate 2. Sports fields in the Jordan Park
Church and parish	Church in Czeladź-Piaski (originally the temple functioned as Saint Angela's church, in the erection decree it was called the Church of the Seven Sorrows of the Blessed Virgin Mary, in 1939 it was changed to the Church of Our Lady of Sorrows): a) church buildings, b) parish cemetery, c) building so-called "Catholic House", d) presbytery.
Monuments	Miners monument at the intersection of streets: Wladyslaw Sikorski St. and Tadeusz Kosciuszko St.

Source: own.

The elements of post-industrial heritage identified in Czeladź Commune make considerable opportunities and possibilities to disseminate, promote and commercialize this potential to create new projects, such as a comprehensive product of post-industrial tourism. The Saturn Museum, as an institution raised to promote the culture and history of the town and region, is one of the entities interested in creating a new and attractive CTP for Czeladź Commune. Therefore, the employees of Saturn Museum were asked to design a few alternatives of such CTP that could be proposed to the local authorities as the future investing projects. This will lead to the decision-making problem related to the selection of the best product variant for post-industrial heritage, considering several potential alternatives built.

One of the reasons why employees of the Saturn Museum distinguished such alternative product variants is that CTPs can take different categories or types. The intention of the museum staff was to present several alternative variants that would include both simple products so-called mono-products, which are single, homogeneous products and composite products – multi-products that are constructed of various simple categories and types of CTPs.

Complex CTPs can have a multidimensional form, as they can be composed, for example, based on such dimensions as (a) product category and (b) product type (a form of their „reality": traditional or virtual). Among the categories of the tourism product, the following can be distinguished (Burkart, Medlik, 1981; Mason, 2016; Medlik, Middleton, 1973; Stokes, 2008; Yu, Xu, 2019):

1. product-thing or product-material good (tourist guidebook, map, etc.),
2. product-service (thematic tourist guide, hotel and catering services, etc.),
3. product-event (post-industrial festivities, picnics, etc.),
4. product-services set (themed rallies, trips, running competitions, etc.),
5. product-object (museum, post-industrial monuments, buildings),
6. product-route (traditional, real post-industrial heritage route, etc.),
7. product-area (comprehensive post-industrial heritage area).

Another dimension that can be taken into account when creating a complex cultural tourism product is to distinguish between types (forms) that relate to the form itself (real or unreal) of the product:

1. real type (traditional, material),
2. multimedia type (digital forms of text, pictures, photos, films, animations etc.),
3. virtual type:
   (a) - in the cyberspace e.g. in the Internet;
   (b) - Augmented Reality – in the software and applications for computers and mobile devices),
4. mixed type – hybrid (various combinations of the types given above).

Therefore, a multiple criteria decision problem arises regarding the assessment of predefined alternative decision variants of the CTP, which, using various categories, types, and forms, would be the best option for promoting a diverse post-industrial heritage in Czeladź.

4 A DECISION FRAMEWORK FOR RANKING POST-INDUSTRIAL CTP OPTIONS

The decision problem of evaluating post-industrial CTP options will be addressed based on the decision framework illustrated in Figure 2. This framework was developed and adapted from the 12-step framework proposed by De Almeida et al. (2015), with some steps being simplified in order to fit the current application better. The 12-step framework is mainly divided into three main phases: preliminary phase, preference modeling phase, and finalization phase.

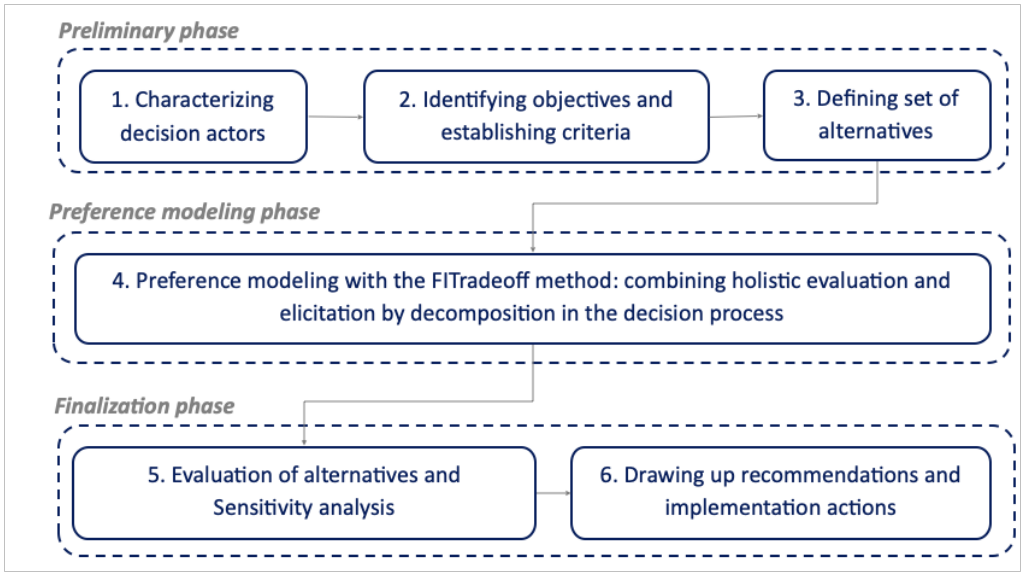


Figure 2 – Framework to guide the decision process.

The preliminary phase consists of three key steps within this decision framework. First (see step 1 in Figure 2), the decision-maker and other actors are characterized; these other actors can play different roles in this process (De Almeida et al., 2015), such as: an analyst with a good background in the decision methodologies to guide the decision process; specialists to aid the data collection and structuration; stakeholders that may have different particular interests related to the decision process. Then, in the second step (see step 2 in Figure 2), the decision objectives are identified and transformed into criteria that are able to measure such objectives. In the third step (see step 3 in Figure 2), the set of alternatives is established, and a consequences matrix is defined so that these alternatives can be evaluated with respect to each criterion set up in step 2.

By following the process in Figure 2, we move to the preference modeling phase, which consists of applying the FITradeoff method to elicit decision makers' preferences and solve the decision problem. The whole application is based on an interactive web-based Decision Support System freely available at http://www.cdsid.org.br/fitradeoff. First, the input data defined in step 3 is inserted into the system. An intracriteria evaluation is conducted with the definition of the form of the value function, and then the decision maker ranks the criteria scaling constants. Thereafter, the preference modeling is conducted in a flexible way, with the possibility of interchanging between two types of preference modeling: elicitation by decomposition and holistic evaluation (De Almeida et al., 2021), which can improve the decision process by fastening the reach to a final solution.

Moving to the finalization phase, the DM obtains the final results from the DSS, and the sensitivity analysis can be performed (see Step 5 in Figure 2). The FITradeoff DSS provides a module in which the sensitivity analysis can be conducted. Sensitivity analysis allows one to verify the ro-

bustness of the solution obtained, considering possible changes in the values of the consequences matrix. Finally, recommendations can be drawn from the results obtained, and implementation actions are considered.

The following subtopics address, respectively, the preliminary phase (Section 4.1) and the preference modeling phase (Section 4.2). The finalization phase will be addressed in Section 5.

4.1 Preliminary Phase

According to the framework presented, the first step of the preliminary phase requires identifying the decision-makers. In the problem under consideration, many stakeholders may be identified at various organizational levels, and they were described previously by Czekajski et al. (2021). We may distinguish the following stakeholders: (1) at the level of the local government unit (LGU) of the Czeladź (e.g., the Mayor of Czeladź Commune and his deputies; (2) units, entities, and institutions subordinate to the Czeladź Commune (e.g., municipal cultural institutions such as "Saturn" Museum); (3) non-governmental organizations promoting culture (e.g., Educational and Cultural Association "Razem"); and (4) municipal educational institutions (i.e., schools). However, in this paper, we consider the problem from the viewpoint of a single DM, which is the representative of subordinate institutions, i.e., the Saturn Museum.

Based on the literature review (see, e.g., Fuadillah & Murwatiningsih, 2018; Ramírez Guerrero et al., 2020), the list of possible evaluation criteria that address the major goals of any CTP was presented to the DM (Table 2).

Next, the alternatives were identified. They were determined using brainstorming over the cultural heritage potential of Czeladź identified earlier by the facilitator, who was one of the authors of this paper (see section 3). The alternatives are various instances of multi-products that can be designed within a reasonable budget assumed by the DM (see Table 3).

The decision matrix for the problem under consideration may be built if the performances of the alternatives with respect to all criteria are defined. Hence, the DM was asked to use a simple 5-point Likert scale to express their opinion about the single-criterion performances of the alternatives. The results are shown in Table 4.

Table 2 – List of key criteria evaluating CTP related to post-industrial heritage.

Criterion code	Name of standardised criteria	Characteristics of the criteria
NEW_TECH	New technologies in product development and its promotion	Does the product use new technologies, such as beacons, QR codes, mobile applications, web 2.0/3.0 technology, travel planners, geotagging, multimedia platforms, ICT systems, and e-books?
ECON	Economic and social importance of the product for the development of the region	What is the product's economic and social importance for the development of the region? This includes (1) economic potential of the product; (2) product image, i.e., perception of the offer on the tourist market; (3) economic effect; (4) integration of the local community; (5) estimated future volume of tourist traffic; (6) tourist destination area.
INFR	General infrastructure	How much the product influences the development of infrastructure such as (1) tourist facilities; (2) recreational attractions; (3) accommodation base; (4) food and entertainment facilities; (6) transport and communication accessibility, (7) transport at the destination; (8) tourist and sports equipment and its rentals; (9) souvenirs shops.
EVENTS	Cultural events	Is the planned product conducive to such events as festivities, picnics, festivals, exhibitions, etc.
EXPER	New experiences, emotions and impressions, new social contacts	Does the product have a positive effect on (1) getting to know the place, attraction, value, heritage; (2) excitement, fascination with the visited place; (3) establishing a relationship with people who experience and feel alike.
PROM	Promotion of the LGU	Is the product promoting the area of LGU, increasing the value of the LGU's tourist offer and building its image? Is it strengthening the competitiveness of the LGU on the regional market of tourist services?
EDU	Education	Does the product affect the quality of the educational offer (e.g. giving the possibility of conducting thematic lessons or creating educational trials)

Source: own.

Table 3 – Examples of alternative decision variants of CTP related to the promotion of post-industrial cultural heritage occurring in the Czeladź Commune.

Code	Alternative description	Type of product	Description
A1	Route of Postindustria (ROUTE)	Product-route in real form and/or Product-thing in a hybrid form	Thematic cultural route leading through the most important points (places) of post-industrial heritage. The route also consists of dedicated, thematic sub-routes and educational trails concerning the technical monuments (machines, devices) and residential architecture.
A2	Postindustria Family Festivals (FESTIVALS)	Product-event in a real form and/or Product-event in a hybrid form	Thematic tourist and cultural events containing such attractions as educational workshops, outdoor family games, do it yourself (DIY) workshops, multimedia presentation of places, traces, artefacts.
A3	Postindustria Family Rally (RALLY)	Product-services set in real form	Thematic annual sports, tourist and culture event with elements of learning (workshops) about post-industrial culture.
A4	Postindustria Quest of Czeladź (QUEST)	Product-route in real form with questing and/or product-route in hybrid form with questing	Questing of post-industrial cultural heritage; outdoor game solving puzzles, tasks, quizzes, and finding the password.
A5	Postindustria Museum (MUSEUM)	Product-object in real form and/or product-object in hybrid form	Temporary, cyclical (once a year) exhibitions at the "Saturn" Museum and Contemporary Art Gallery "Elektrownia".
A6	"Terra Postindustria" (AREA)	Product-area in the real form	Thematic geographically determined area of the former two coal mines, their patron estates and other infrastructure sites with routes, trails, questing games, cultural tourism facilities.
A7	"Postindustria Story" (STORY)	Product-service in real form and/or Product-service in hybrid form	Thematic story-based guided tour of the entire area related to the two mines and their heritage, divided into several thematic sections: (1) technical monuments, (2) residential architecture, (3) recreation, entertainment and (4) everyday life of mine workers, customs, rituals.
A8	Portfolio product A (PORTFOLIO A)	Material good (thing) + service + route	Map of post-industrial attractions, guide service of the most important attractions, thematic route through the most important post-industrial attractions
A9	Portfolio product B (PORTFOLIO B)	Event + services set + virtual route	Thematic tourist and cultural festivities, picnics, festivals, exhibitions, etc. Thematic, sports, tourist rally with elements of learning about post-industrial culture. Virtual route on the web.
A10	Portfolio product C (PORTFOLIO C)	Product-thing in multimedia form + virtual service + virtual route	Interactive map of attractions (with photos, videos, graphics, animations), including virtual tour combined with the audiobooks through the virtual route on the website.

Source: own.

Table 4 – Decision matrix for the problem of prioritizing the CTPs for post-industrial attractions in Czeladź.

Alternatives	NEW_TECH	ECON	INFR	EVENTS	EXPER	PROMOTION	EDU
A1	4	3	4	1	3	5	4
A2	3	3	3	5	4	3	3
A3	3	3	3	2	3	3	3
A4	4	3	3	2	4	4	4
A5	3	3	3	3	2	3	5
A6	3	4	4	2	3	4	4
A7	2	2	3	2	3	3	4
A8	3	3	4	2	3	4	4
A9	4	3	4	5	4	4	4
A10	5	3	4	2	4	3	3

Source: own.

4.2 Preference Modeling Phase

The preference modeling phase consists on the application of the FITradeoff method, operationalized by the FITradeoff decision support system. The process starts by entering the input data - which consists basically on the consequences matrix presented in Table 4 - into the system. In the intracriteria evaluation, linear value functions were considered for all criteria. Then, the decision maker ranked criteria scaling constants choosing an "overall evaluation" approach provided by the FITradeoff DSS. As a result of this step, the following order was obtained: $k(PROMOTION) > k(NEW\_TECH) > k(ECON) > k(EXPER) > k(EVENTS) > k(EDU) > k(INFR)$.

This information of criteria scaling constants ranking is incorporated into the mathematical model of the FITradeoff method (De Almeida et al., 2016; Frej et al., 2019; De Almeida et al., 2021) and partial results are computed based on this first round of the model. Since a ranking problematic is being considered, the partial results in this case consists on a partial ranking of the alternatives, which was obtained from the dominance relations that could be established based on the information of criteria weights ranking (Frej et al., 2019). At this point, three ranking levels were achieved, and the image shown in Figure 3 is displayed by the FITradeoff DSS, asking in which way the DM wants to continue the decision process: with the elicitation by decomposition or switch to a holistic evaluation. The flexibility of the DSS allows the DM to change between these two types of preference modeling, during the process. The process should be guided by an analyst, that could show the DM the different possibilities and how the decision process could be improved based on the combination of these two paradigms in preference modeling (De Almeida et al., 2021).

In order to decide in which way he wanted to continue the process at this point, the DM first opted to visualize the partial results obtained, which are displayed in Figure 4. The arrows represent

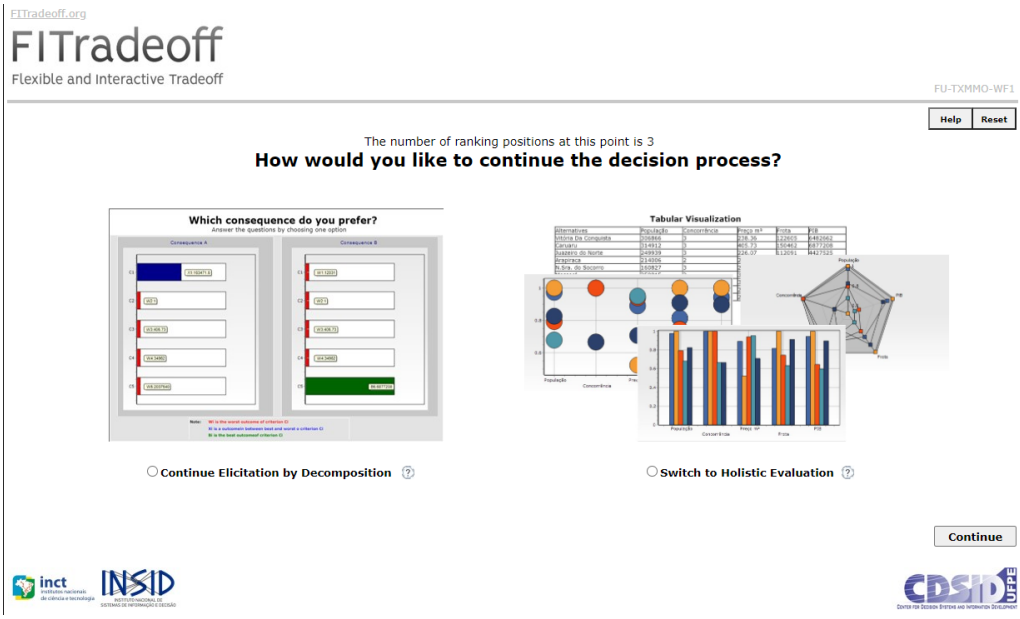


Figure 3 – Choosing between elicitation by decomposition and holistic evaluation in FITradeoff DSS.

dominance relations between alternatives, with the transitivity reduction property being satisfied (Frej et al., 2019). The absence of an arrow between two alternatives indicates that they are still incomparable for the current level of information provided until that point; i.e., no dominance relation can be defined between them. In this sense, it can seen in Figure 4 that the worst alternative has already been defined: A7. In the two first rank positions, there are still lots of incomparable relations at this point. Hence, it is quite difficult for the decision maker to choose a pair of alternatives to compare in a holistic way. Therefore, at this point, the DM chose to continue in the elicitation by decomposition.

In the elicitation by decomposition in FITradeoff, the DM answers preference questions in the consequences space, considering tradeoffs between criteria. Figure 5 shows an illustration of a question made for the DM in the elicitation by decomposition. The DM is asked about his preference between two consequences: Consequence A, with a value of 3 in criterion C1 (PROMOTION) and the worst outcome for all other criteria; and Consequence B, with the best performance (5) for criterion C2 (NEW_TECH) and the worst outcome for all other criteria. In the elicitation by decomposition process, the DSS put questions of this type in a sequential manner for the DM, so that he answers considering tradeoffs between different levels of criteria.

At any point during the process, the DM can click on the button shown in the right side of Figure 5, “Show Current Results”, in order to visualize the partial ranking obtained until that point and, if he wants to, perform a holistic evaluation to directly declare a dominance relation between a pair of alternatives. After six preference questions have been answered by the DM, a ranking with six positions was obtained (see Figure 6).

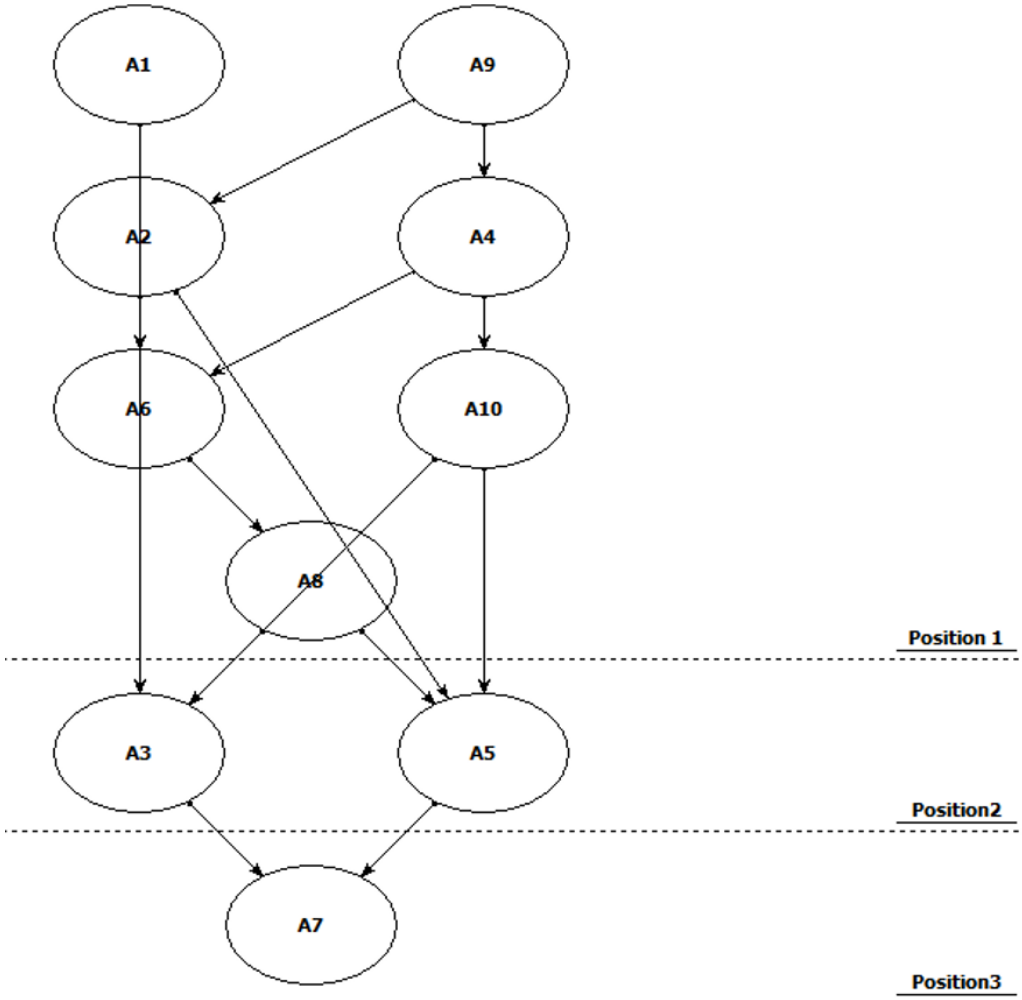


Figure 4 – Partial ranking after ordering criteria scaling constants.

By analyzing Figure 6, it can be seen that there are two ranking levels with incomparability relations between alternatives: Position 1 and Position 3. At this point, the analyst could advise the DM to visualize the graphics provided the DSS to analyze the possibility of performing holistic evaluations in order to solve such incomparability relations. In this sense, the DM would be able to visualize the alternatives that belong to a certain ranking position and compare them. By choosing to visualize alternatives in Position 3, for instance, the bar graphic shown in Figure 7 would be displayed for the DM.

Figure 7 illustrates the performance of the alternatives that belong to position 3, in a comparative manner. Each color represents an alternative, and the height of the bar indicates the performance of each alternative normalized in a ratio scale from 0 to 1. Criteria are ordered from left to right.

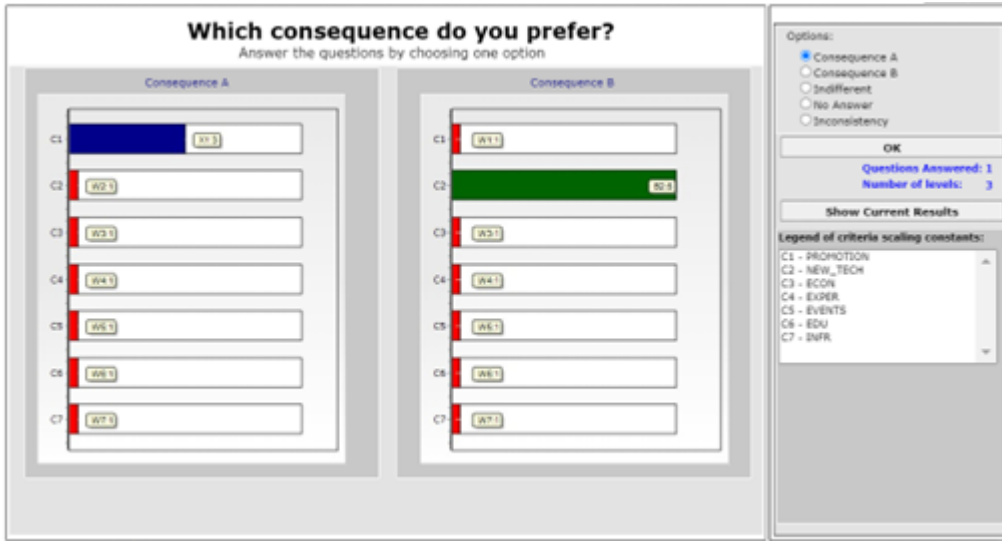


Figure 5 – Elicitation by decomposition question in FITradeoff DSS.

The DSS also allows the DM to select a subset of alternatives if it is better for him to analyze this way. Since holistic evaluation is made considering pairs of alternatives in the ranking problematic, it would be better for the DM to choose pairs to analyze. If the DM wanted to perform a holistic evaluation at this point, the information provided would be useful to update the space of weights with additional information; this is the typical case in which holistic evaluation could be used to provide additional information to the model, as highlighted by De Almeida et al (2021). However, at this point, the DM did not feel confident yet to perform a holistic evaluation, since the alternatives seemed very competitive to him based on this analysis. In this sense, he preferred to go back to the elicitation by decomposition and continue answering preference questions in the consequences space.

After three more questions have been answered, a ranking with nine positions was obtained, as can be seen in Figure 8. At this point, there is a unique incomparability relation in position 4 that should be solved in order to achieve a complete order of the alternatives: A6 and A10 are still incomparable to each other. This is a typical situation in which the holistic evaluation can be used to finalize the decision process, as highlighted by De Almeida et al (2021). It means that, if the DM is able to perform a holistic judgement at this point declaring preference by A6 over A10 or by A10 over A6, a complete ranking would be found and the decision process would be finalized.

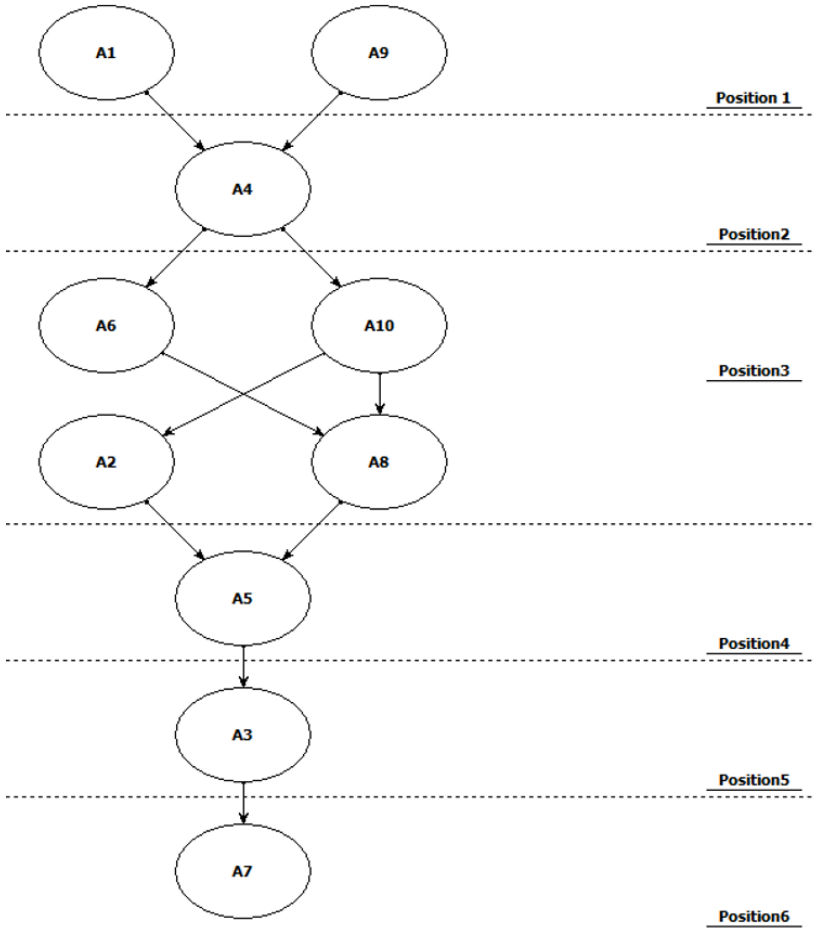


Figure 6 – Partial ranking after six preference questions.

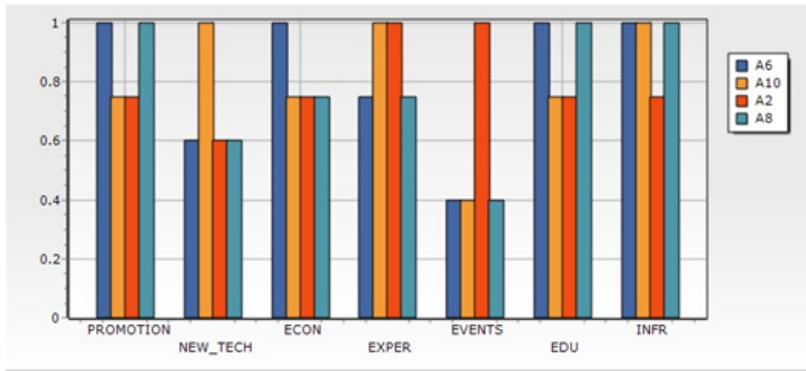


Figure 7 – Bar graphic of the alternatives in position 3.

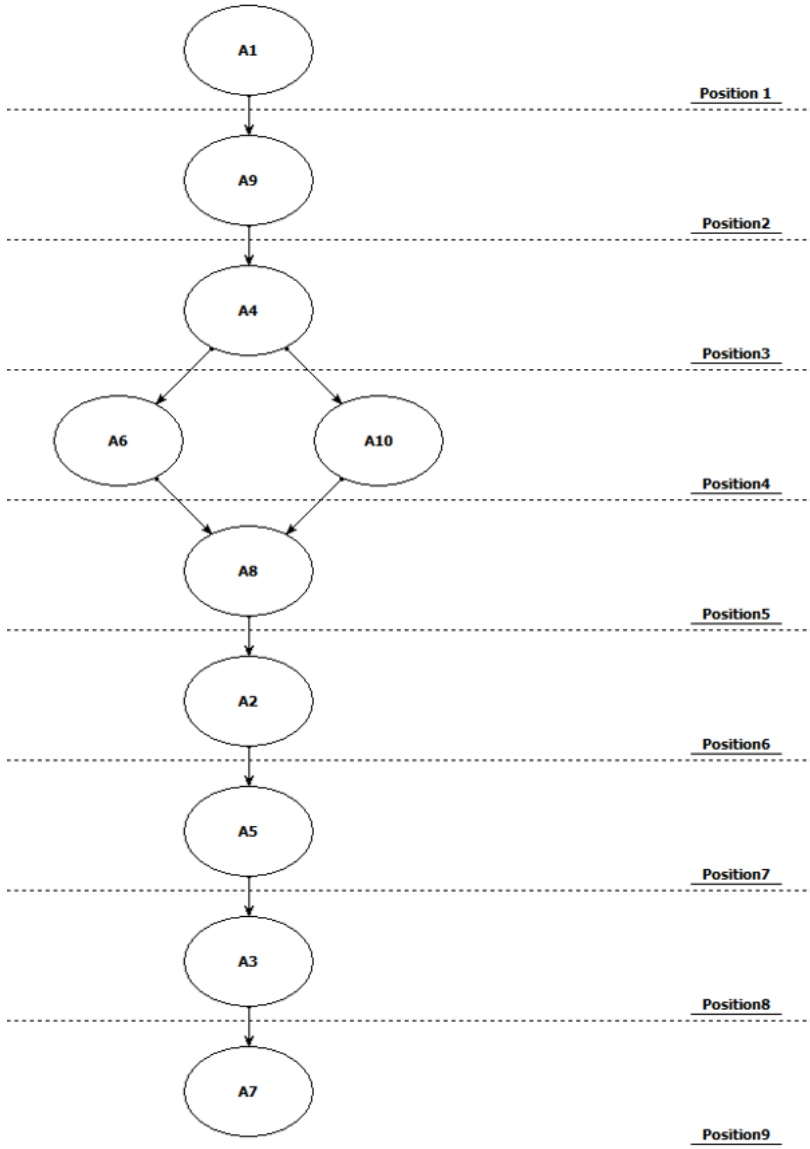


Figure 8 – Partial ranking after nine preference questions.

Figure 9 shows a bar graphic comparing alternatives A6 e A10, that would be available for the DM at this point of the process. The blue bar represents alternative A6, and the orange bar represents A10. In two out of seven criteria, EVENTS e INFR these two alternatives are tied with the same outcome, and therefore these two criteria can be excluded from the comparative analysis. Alternative A6 has an advantage of almost 30% over alternative A10 in three criteria: PROMOTION (which is the first-ranked criterion), ECON and EDU. Alternative A10 has an advantage of 40% in two criteria: NEW_TECH and EXPER. Based on this analysis, alternative

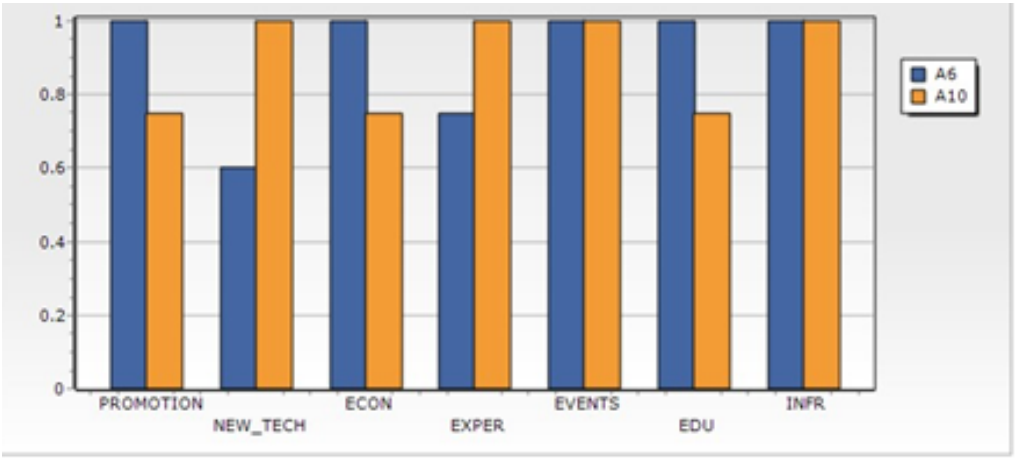


Figure 9 – Bar graphic of the alternatives in position 4.

A6 could be considered to be better than alternative A10, and therefore a dominance relation from A6 over A10 could be defined in a holistic evaluation at this point, finalizing the decision process since a complete ranking would be achieved.

This is a role of the analyst to guide the DM in this kind of analysis; but the final decision to perform or not a holistic judgment at any point during the process is from the DM. It should be highlighted that the possibility of performing a holistic evaluation is part of the flexibility of the method, which allows the DM to interchange between the two paradigms in preference modeling. The next section discusses the final results obtained by the model, with emphasis on the finalization phase of Figure 2.

5 RESULTS AND DISCUSSION

After performing a holistic evaluation declaring preference for A6 over A10, a complete ranking of the alternatives was achieved, as shown in Figure 10. The arrow marked in red indicated that the dominance relation that it represents was obtained from a holistic evaluation. Hence, the decision process was finalized with 9 decomposition questions answered by the DM and a single holistic evaluation at the end. It should be highlighted that, in this case, the holistic evaluation fastened the decision process, in a sense that, if the DM continued with the elicitation by decomposition, some additional preference questions would have to be answered for a complete ranking to be achieved.

As an output of the FITradeoff DSS, a graphic with the ranges of values of each criteria scaling constant can be visualized at the end of the process. Figure 11 shows the graphic that illustrates the space of weights that corresponds to the final ranking obtained by the model. It means that, for any vector of weights within this range (and summing up to 1), the ranking of alternatives remains

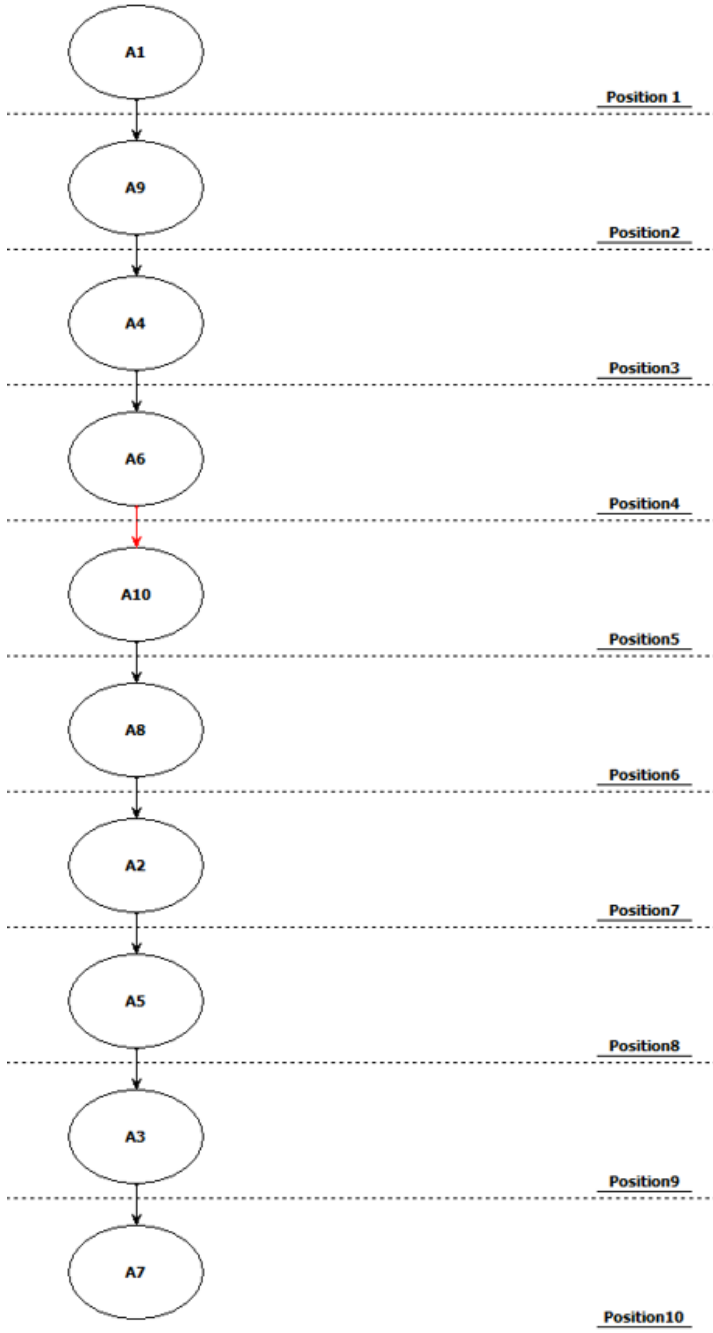


Figure 10 – Complete ranking of the alternatives.

the same of that shown in Figure 10. This can be interpreted as a measure of the robustness of the final ranking with regard to possible variations of the values of the criteria scaling constants.

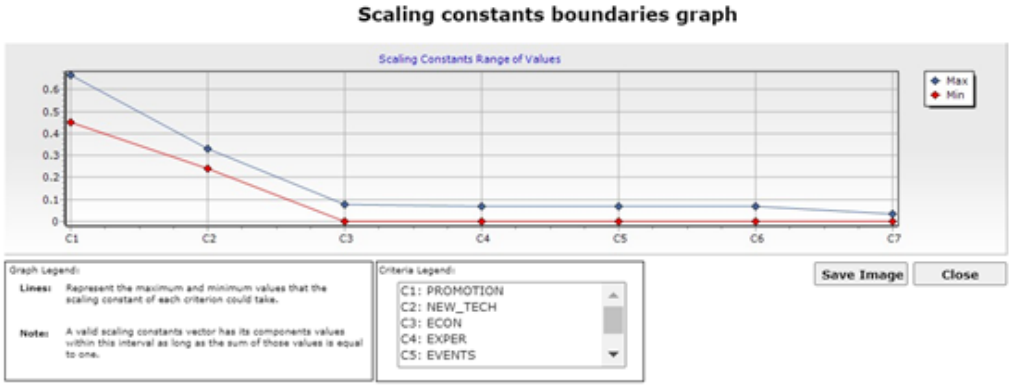


Figure 11 – Limits of criteria scaling constants.

As part of the finalization phase shown in Figure 2, a sensitivity analysis was conducted in the FITradeoff DSS. The sensitivity analysis in FITradeoff was carried out based on a Monte-Carlo simulation process, through which it is possible to analyze how the output of the model (final ranking) changes with the variation of values in the consequences matrix. For this case, all criteria were set to vary ±10%. Figure 12 shows the output of the sensitivity analysis. The graphic at the bottom of the figure indicates the percentage of simulation cases in which an alternative remains in the original position (blue bar) and the percentage of cases in which an alternative changes position (purple bar).

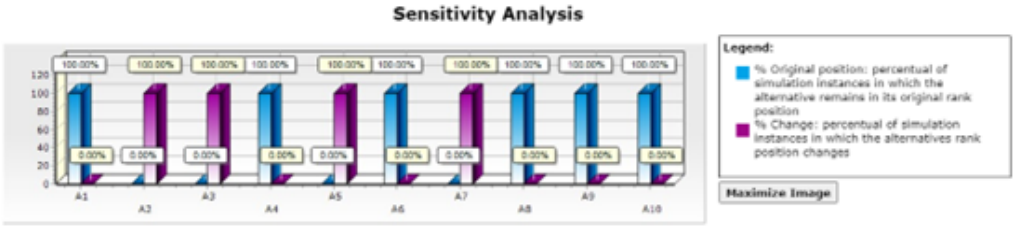


Figure 12 – Sensitivity analysis results.

It can be seen that the first six ranked alternatives (A1, A9, A4, A6, A10, A8) remained in their original position in 100% of the cases. On the other hand, the four worst-ranked alternatives (A2, A5, A3, A7) change position in 100% of the simulated cases. It shows that the best alternatives are quite robust in their position, considering a possible variation of values in the consequences matrix; however, the worst ones are extremely unstable in their positions. Since the decision maker is more interested in implementing the best-ranked alternatives, the sensitivity analysis results indicate that they are stable considering possible variations of consequences.

By using the methodology of holistic evaluation of alternative CTP variants presented above, the final results were obtained and a report was generated for a single decision-maker (Saturn Museum). The final solutions and information received are recommendations to the museum, but they are also element of the preparation (from the museum point of view) to broader discussion and cooperation with other DMs and stakeholders. There could be two ways of further proceeding and taking action in the implementation of one of the selected alternative CTP variants. The first recommendation is that the estimation of ranges of criteria and final rank order of CTP alternartives, the "Saturn" Museum managers will be able to prepare prenegotiation activities for the forthcoming negotiations with other stakeholders. The second recommendation is to conduct a group (together with selected stakeholders) assessment of the ranks of the criteria and obtain the resulting rank order. This is aimed at final negotiations between the stakeholders, which will concern the selection of the CTP variant for implementation.

6 CONCLUSIONS

This work presented the possibilities of combining holistic evaluation and elicitation by decomposition combination in the FITradeoff decision process in the context of estimating predefined alternative CTPs variants as well as identification of the post-industrial heritage of Czeladź Commune and a decision analysis of the performance of potential CTPs that may promote it.

Overall, the new flexibility feature of the combination of two types of preference modeling (elicitation by decomposition and holistic evaluation) recently incorporated into the FITradeoff method by De Almeida et al (2021) could be illustrated in case treated in this paper. It could be seen that making a holistic evaluation can indeed shorted the preference modeling process, saving time and effort from the decision maker. This happens because, by defining a preference relation in a holistic manner, the DM does not need to answer additional questions in the elicitation by decomposition process, which could delay the process. It should be highlighted, however, that the case presented in this paper illustrates a particular case in which the holistic evaluation is used to finalize the decision process. There are other ways in which this kind of evaluation can bring benefits for decision process, without the need to finalize it; for instance, when a holistic evaluation is performed in the middle of the process, and the information obtained is used to update the space of weights with new inequalities obtained from the comparison of alternatives' global values (De Almeida et al., 2021).

Another point that should be raised here is the role of the analyst in the whole process, to guide the decision maker on the possible ways to follow along the decision-making process. The analyst can advise the DM to perform a holistic evaluation at some point, and therefore he should help the DM also in the interpretations of the graphics provided by the FITradeoff DSS, so that the DM becomes able to make a comparison between alternatives in a reliable way. Nevertheless, the final decision of performing or not a holistic evaluation should be made by the DM, depending on his willingness to do so. The flexibility of the FITradeoff DSS allows the DM to change between the two preference modeling paradigms: elicitation by decomposition and holistic evaluation,

without the need to follow a predefined fixed process, in such a way that the DM – aided by the analyst – chooses the best way to follow.

The decision problem related to the assessment and selection of the best CTP variant from the hypothetically prepared alternative options for this product was presented from the point of view of one decision-maker – Saturn Museum in Czeladź. The selection of the key decision criteria, as well as the assessment of variants in relation to these criteria, can be considered as burdened with the error of one-sided preferential information of the decision-maker (Saturn Museum). Perhaps the Saturn Museum's focused perspective on solutions, e.g. in the form of the most anticipated variants: A1 – post-industrial route, A9 – product portfolio „B", A4 – post-industrial questing or A6 – product-area „Terra Postindustria" was decisive here. influence on the ways of modeling preferences.

In the obtained ranking of alternative CTP variants, the A1 (ROUTE) variant – Route of Postindustria, was in the first place. The premise of such a product is that it is meant to be thematic cultural route leading through the most important points (places) of post-industrial heritage in Czeladź Commune. The main route can also consist of dedicated, thematic sub-routes and educational trails concerning for example: (a) the technical monuments (machines, devices), (b) architectural monuments, (c) residential architecture – in particular, patronage workers' housing estates.

The alternative CTP in the form of route should be viewed not as a mono-product but as a composite product. Therefore, it will also consist of simple tourism products such as: a guide, a map, guide service, etc. It can be also expanded with other products, such as a product-event, which may be the so-called "Route Open Day" or "Route Festival".

The thematic route becomes for the museum a very important product promoting the post-industrial heritage, because, among others: (a) tourists get to know and visit the objects and places located on the route, (b) the route with, e.g., a book guide and a map, comprehensively presents this heritage, (c) the production of the first complex product in Czeladź may take place, which promotes the post-industrial values of the two former mines. The thematic cultural route becomes not only another tourist product in the local tourist offer, but also an additional tool for territorial marketing and promotion of the Czeladź in the region, and even throughout Poland.

For future studies, it is highly recommended that the opinion of other stakeholders are also taken into account, since this decision problem is inherently a group decision making problem that involves multiple actors aspirations.

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