# Evaluating upskilling tools for digital, green, and entrepreneurial competences: A multicriteria approach to advancing Europe's green and digital transition

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**Abstract.** Advancing green and digital transition is a key topic on Europe's agenda, aligned with the UN's SDG goals. In this context, this study investigates existing support tools and programs for upskilling digital, green, and entrepreneurial (DGE) competences with the goal to select and reuse the best ones available within the project partner group (11 partners from 9 European countries). The data collection process started with the identification and thorough elaboration of 90 upskilling tools/programs, each differing in their contributions to DGE competences, and in other varying features. The collected database contains more than 30 qualitative and quantitative features per upskilling tool/program. An expert focus group then defined the tool selection criteria and their grading, highlighting the importance of learning outcomes recognition and the development of multiple DGE competence areas, in particular. After the grading process, alternative assessments were analysed using the PROMETHEE II method, resulting in a ranking of the 15 most useful DGE tools/programs. In addition to validating the framework set up for the MCDM that takes into account the complexities of (international) training needs of diverse target groups, the study demonstrated significant application potential. Namely, these tools, both the initial list of 90 and the selected 15, all having confirmed their effectiveness and success in previous projects addressing SDG 4 and SDG 9, are now promoted to (new) relevant stakeholders and prioritised in capacity-building actions in international settings. As such, the collective exercise based on strong scientific foundations had clear practical value.

**Keywords**: PROMETHEE, SDG4 Quality education, SDG 9 Industry, innovation and infrastructure, upskilling

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## 1. Introduction

The transition towards a green and digital economy has become a central focus on Europe's agenda, reflecting global commitments such as the United Nations' Sustainable Development Goals (SDGs). As economies and societies strive to meet these goals, the demand for effective upskilling tools and programs has never been more pressing. SDG 4, which emphasises quality education, and SDG 9, which focuses on industry, innovation, and infrastructure, emphasise the need for developing competences in digital, green, and entrepreneurial (DGE) areas, in particular. [13] raises the importance of competence frameworks in shaping the future workforce through education and estimating the future performance of existing business operations. Similarly, [17] in their study of sustainable entrepreneurship recognise digital technology support as

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beneficial in avoiding and exploiting the potential of environmental and social challenges. Still, the body of knowledge addressing digital and sustainable entrepreneurship is too dispersed and fragmented to serve as the foundation for development (ibid).

While the fourth industrial revolution era is based on digitalisation, with economic growth and social progress depending on technological innovation, the fifth industrial revolution can be seen as green – merging ecology, technology, sociology, science, math, and economics fields [16]. Eventually, it will lead to a more sustainable future. The role of education in this transition is of great importance. To achieve its potential, educational practices need to be transformed into learning on matters related to sustainable development [25] and genuine commitment to educational paradigm change. Accordingly, existing competence frameworks brought forth by the European Commission – DigComp, GreenComp, and EntreComp, can be valuable tools in estimating the current situation and clarifying future paths.

This study seeks to address the gap between current educational offerings and the competencies required for sustainable and innovative growth. Building on the expertise of DGE training and support, the primary objective was to identify and rank the most effective tools and programs available to a collaborative network of 11 partners from nine countries. The scope of this investigation covers a diverse range of 90 tools and programs, each varying in its approach and contribution to DGE competence development. The important questions for businesses, individuals, education institutions and business support organisations are related to the selection of DGE tools and programs that will enhance their (individual) competences, but at the same time bring value to their respective organisations. These questions clearly point to a multi-criterial problem faced by decision-makers, which is investigated in this occasion using a Multi-Criteria Decision-Making (MCDM) method as a framework for scientifically sound decision support in an effort to effectively upskill future and existing workforce, in particular their DGE competences.

With regards to the contribution, by systematically analyzing a diverse range of tools and programs, the paper aims to provide a comprehensive portfolio that not only enhances individual competences but also adds significant value to organizations and educational institutions. The contribution lies not only in the identification and ranking of these tools but also in the establishment of a robust methodological framework that incorporates expert evaluations and stakeholder insights. This framework is designed to facilitate the effective upskilling of the current and future workforce, particularly in the realms of digitalization and sustainability. Furthermore, by promoting the selected tools to relevant stakeholders and prioritizing them in capacity-building actions, this research has the potential to drive significant advancements in the green and digital transition across Europe. Consequently, this study not only enriches the academic discourse on integrating multiple competence frameworks but also provides actionable insights grounded in empirical evidence. By empowering stakeholders to make data-informed decisions regarding the implementation of impactful tools and programs, the aim is to advance sustainable and inclusive growth in various educational and professional sectors.

The paper is organized as follows: Section 2 provides a literature overview of DGE competences. Section 3 explains the research data and methodology. Section 4 presents the research results, including a sensitivity analysis and discussion. Finally, Section 5 offers concluding remarks.

## 2. Literature review

A relatively scarce but emerging body of literature on sustainable entrepreneurship emphasises the potential of digital technologies to prevent further development of threats related to environmental and social challenges [17]. Sustainable and innovative growth depends, at least partly, on quality entrepreneurship education and training programs. Still, a slow pace in adaptation to circularity and sustainability can be seen in entrepreneurship program development

due to a need for more experience in introducing this important topic into study programs [38]. Green topics and digital technologies will play a crucial role in this transition [16], while the complexity and importance of the subject raise the urge for a multi-dimensional approach and solutions.

In that sense, critical terms related to the further development of the discipline are digitalisation, sustainability and entrepreneurship, whereas their interconnections should be investigated further ([29]; [15]). [17] proposed a comprehensive framework based on a systematic literature review that contributes to the role of business models for sustainability with the reconceptualisation of digital technologies as business model actors. In this model, sustainability and digitalisation are integrated into business operations, while outcomes are oriented toward multiple stakeholders, venture viability and value for society and the environment.

Furthermore, [18] emphasise the vulnerability of SMEs due to sustainability and digitalisation issues with a high level of reactive response. It can be argued that a higher level of competences in digital, green, or entrepreneurship will lead to higher resilience of actors in today's fast-changing environment. Therefore, entrepreneurs and future entrepreneurs should be able to evaluate their competences to improve them in the future and become more resilient to crises.

According to [36], entrepreneurial competences mediate the relationship between digital entrepreneurial education and entrepreneurial intentions. [12] noted that the promotion of entrepreneurial skills among students might contribute to sustainable development due to the development of entrepreneurial skills of self-consciousness and its relationship with environmental commitment. In that sense, DigComp [39], GreenComp [8] and EntreComp [6] frameworks can be helpful tools to estimate and track the progress toward upskilling for sustainability.

There is a rise of interest in exploring these frameworks' usefulness and operationalisation. Still, most studies focus on a single competence framework. For example, [22] claim that EntreComp can be addressed as a unidimensional construct which explains start-up behaviour. [35] emphasise the urge for further support in EntreComp implementation in policy-driven frameworks, while [6] emphasises complexity in the development of entrepreneurial competences measurement scales, therefore, an unclear vision of what competences should be developed through education programs.

The body of knowledge on DigComp and GreenComp implementation and effectiveness is also limited. [14] analysed initiatives at the EU level related to digital readiness of higher education, emphasising challenges relatively similar to prior findings and determining the main obstacles in developing digital skills. Although DigComp provides a structured approach in various elements of digital proficiency [7], the willingness to adopt and implement this approach among key stakeholders is crucial for further development. [32] indicate overlap and cause-related relationship between GreenComp and EntreComp, suggesting that GreenComp should be seen as a part of EntreComp, while their combined usage is a precondition in the transition from system thinking to action. A combination of all frameworks in achieving necessary competences is mandatory for sustainable entrepreneurship education and practice (ibid) in the future.

In terms of upskilling, [3] explored the usability of DigCom in employability after finishing education. Their findings suggest that attitudes moderate the relationship between digital competences and employability, where diverse nature and requirements across different sectors should be considered. GreenComp, a relatively new concept directly related to sustainability, is least present in the current body of knowledge. [37] emphasise its flexibility to serve as a framework for different purposes, which is why it should be widely used for educational and business purposes.

There is a consensus that the European Commission's competence frameworks should become standard in estimating needed competences and creating appropriate training programs accordingly. If the unified approach is adopted, it might be possible to measure, track and

compare effects, creating a foundation for equal development toward sustainability. To follow up on this ambition, this study seeks to find its contribution. Despite this agreement that a holistic approach to competence frameworks is needed, ready-to-use solutions still need to be developed. Reasons for this discrepancy can be derived from subject complexity. Namely, according to [11] , frameworks' competences address knowledge, skills, values and attitudes that should be estimated from critical and transformative perspectives. They conclude that this is only possible if competences are perceived from a learning perspective that leads to reductionism and a pragmatic approach to complex subjects. Therefore, other competences, such as emotional management and uncertainty, should be included, with a "learning to be" perspective. The combination of multiple competence frameworks as a tool for sustainable growth can be expected to be in the scope of researchers in the future. Furthermore, the joint effect of technological innovation and green orientation might be crucial elements of an organisation's success [33], where organisations are "forced" to pursue innovation.

In addition to the analysis related to competence frameworks and various aspects of DGE-related upskilling presented above, additional empirical studies employing MCDM in educational or sustainability contexts have been examined. Some, for example, use MCDM methods to benchmark e-Learning tools, helping users and developers select tools with optimal features for training and course development [21], to recommend optimal learning paths for students and teachers to enhance educational outcomes [1]), or to identify key enablers for green entrepreneurship and digitalization [30].

Overall, the literature reveals a scarcity of studies that comprehensively integrate multiple competence frameworks specifically targeting DGE-related upskilling needs across diverse contexts. This study addresses this gap by synthesizing multiple competence frameworks into a unified tool designed to meet the specific needs of DGE upskilling. This comprehensive approach goes beyond existing literature, which often focuses on isolated frameworks or aspects of competence development, by exploring and critically evaluating support tools and programs for enhancing DGE competences among a diverse set of project partners. Through this synthesis, the study not only enriches the academic discourse on integrating multiple competence frameworks but also establishes a ranking system that applies internationally validated selection criteria to prioritize the most effective tools for upskilling. By offering actionable insights grounded in empirical evidence, this research empowers stakeholders in their efforts to build DGE capacities and make data-informed decisions on implementing the most impactful tools and programs, ultimately advancing sustainable and inclusive growth in various educational and professional sectors.

## 3. Data and Methodology

### 3.1. Data

Data collection of DGE tools/programs was based on an online questionnaire developed and collated using Qualtrics. The questionnaire was distributed among 11 project partner institutions (Interreg Central Europe Capacity2Transform), all of whom possess extensive expertise in supporting businesses, upskilling, and delivering training programs. There were in total 30 features that merited elaboration per tool/program (including name, category, description, length, delivery flexibility, level of the program, audience, upskilling topic addressed, learning outcome alignment, etc.). Considering 11 professionals entered data (one per institution), two workshops were organised by the authors of this paper, for the participants to reach a common understanding of the purpose of the questionnaire, and the questions and to outline the overall process. After the workshops, data collection started in October 2023 and finished in late December 2023.

At the data collection stage, the targeted number of tools and/or programs/modules was

88 (as each partner had to collect at least 11 tools/programs) and the total collected number was 90 tools/programs addressing various aspects of upskilling support to enhance DGE competences. All collected tools/programs formed a comprehensive project catalogue published at https://capacitytotransform.eu/tool/program-identification-tool/. Each tool was described in an extensive level of quantitative and qualitative detail to capture different features for each item (i.e. determining upskilling topics, delivery mode, learning pace, competence areas, enrolment criteria, intellectual property rights issues etc.).

## 3.2. Methodology

As discussed earlier, due to the complexities of uncovering the best portfolio of tools/programs that would meet the (international) training needs of diverse target groups, MCDM method was identified as the most effective. Namely, MCDM methods provide an overall ranking of alternatives, from the most preferred to the least preferred, based on a stated set of alternatives (in this particular case 90 DGE tools/programs) and a definite number of decision-making criteria. As the aim was to select the 15 best support tools/programs available from the newly founded catalogue, the tool/program selection process incorporated project partners' collective knowledge and experience. The research model is shown in Figure 1 and each phase is described in the following text.

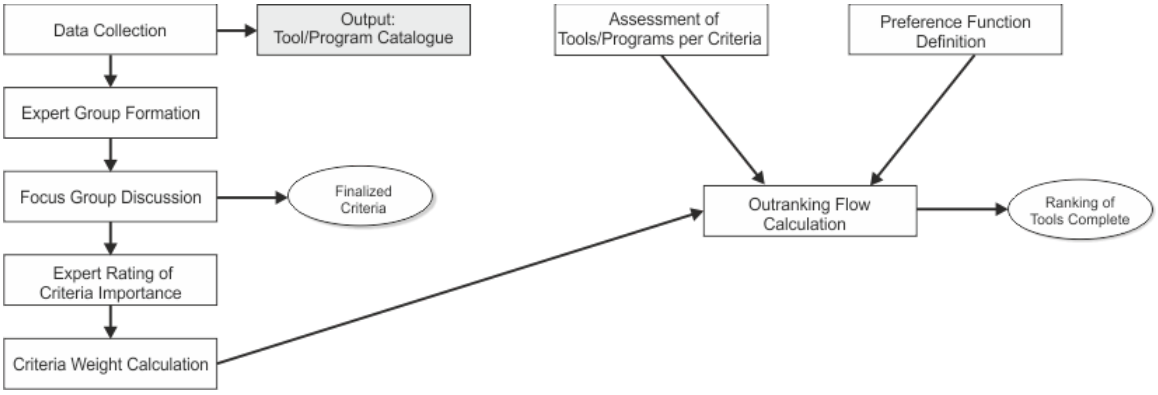


Figure 1: *Study's research model (made by authors)*

First, the criteria formulation process involved creating an expert group comprised of project partners who possess extensive knowledge and experience. All project partner members' competences were evaluated using the DGE competences self-assessment tool European Commission's Digital Competence Framework for Citizen [39], GreenComp: The European sustainability competence framework [8] and EntreComp: The Entrepreneurship Competence Framework [5]. Subsequently, a focus group consisting of seven experts with the highest scores of DGE competences was organised to establish the framework and criteria for tool/program selection. Out of 7 experts, 5 were female, 2 male, 5 had PhD diploma, 2 master diploma and in average they had more than 13 years of experience. The 14 criteria were initially drafted by the focus group moderator (one of the authors of the paper) based on the literature review and were afterwards refined through focus group discussion in a workshop in late January 2024, resulting in a finalised list of 9 criteria (Table 1).

The importance of criteria was assessed by experts as well, using group weight assessment grading. Specifically, after the focus group, the conclusions were collated and 10 experts (3 additional were included who scored the highest in DGE competences) in total were provided with the set criteria (C) and asked to evaluate the importance of the criteria from 1 (not

| Criteria (criteria type) | References | Weights |
|---|---|---|
| C1 Availability of recognition of learning outcomes - reliability (max) | [2] | 0.1089 |
| C2 Development of multiple DGE competences areas (max) | [5]; [8]; [39] | 0.1080 |
| C3 Adaptability - individual learning paces (max) | [1] | 0.1043 |
| C4 Total number of competences' development (max) | [5]; [8], [39] | 0.0999 |
| C5 Level of learner support (max) | [41] | 0.0986 |
| C6 Timeframe flexibility of the program (max) | [31] | 0.0916 |
| C7 Program delivery mode diversity (offline/online) (max) | [9] | 0.0814 |
| C8 Availability of previous users' feedback or rating (max) | [10] | 0.0760 |
| C9 Price (min) | [40] | 0.0524 |

Table 1: *Consolidated list of criteria for DGE upskilling tool/program selection (ranked by weight from highest to lowest) (Source:authors)*

important) to 10 (very important). Out of 10 experts, 6 were female, 4 male, 5 had PhD degree, 4 master degree, one bachelors degree and in average they had more than 15 years of experience. The weights assigned to each criterion in Table 1 are derived from expert evaluations using a scale from 1 to 10. It is important to note that these weights do not sum up to 1 or 100% because they represent raw scores (importance of raw score discussed by e.g. [19] reflecting each criterion's importance rather than normalized proportions. Given that there are nine criteria, the total score reflects this count (9) rather than requiring normalization. This method allows for a more nuanced understanding of each criterion's significance in assessing DGE upskilling tools and programs. For each criterion, a criterion type is noted in brackets (min or max) showing if the criteria are to be maximised (benefit criterion) or minimised (cost criterion). The most important criteria for DGE tools per experts opinions are tools' reliability and development of multiple DGE competences areas. The least important one is tool price. The table also outlines relevant and recent studies that were conducted in a similar context (education/training tools) and have focused on a particular criterion; this is listed in the References column.

Out of the prominent MCDM methods, PROMETHEE (Preference Ranking Organization Method for Enrichment of Evaluations) was pinpointed as the optimal in the given scenario (capability to provide clear rankings and allows strict preference thresholds to be set). As a decision-making technique, PROMETHEE helps to determine the relative rankings of the alternatives based on the overall preferences of experts [4]. It takes into account the criteria weights assigned by the experts to prioritise the tools/programs accordingly and assists in converting qualitative data into an ordinal scale. Alternative methods such as AHP were considered; however, they require normalization of scores and may not accommodate the complexity of our criteria as effectively as PROMETHEE II. TOPSIS and VIKOR were also evaluated but were found lacking in flexibility regarding preference functions and ranking capabilities (e.g. [23]). PROMETHEE has been used in different fields including finance (e.g. share investments by [24], management (e.g. supplier selection in blockchain by [26], regional tourism competitiveness (e.g. [27] and city governance (e.g. selection of IoT platforms by [28]. In the field of education, PROMETHEE has been applied for various purposes, for example, evaluation of school performance [20], remote education software evaluation [41], and more recently for ChatGPT in higher education when evaluating collaborative work alternatives [31].

## 4. Results and Discussion

### 4.1. Results

By using the PROMETHEE II method, the 15 best DGE tools/programs were then selected based on their performance against the established criteria and their respective weights. In

| | | C1 | C2 | C3 | C4 | C5 | C6 | C7 | C8 | C9 |
|---|---|---|---|---|---|---|---|---|---|---|
| | Toola name/Preference Function | Usual | Usual | Usual | V-shape | Usual | Usual | Usual | Usual | Usual |
| A1 | Go Startup Master | 1 | 2 | 2 | 20 | 5 | 1 | 2 | 4 | 1 |
| A2 | DoToho! | 1 | 3 | 3 | 11 | 5 | 4 | 5 | 5 | 4 |
| A3 | EDIH Soc. impact ... and ESG | 5 | 2 | 2 | 5 | 5 | 3 | 2 | 2 | 3 |
| A4 | Startup Ecosystem Canvas | 1 | 3 | 3 | 30 | 3 | 4 | 5 | 1 | 1 |
| A5 | Google Grow tools | 5 | 3 | 5 | 21 | 3 | 5 | 4 | 5 | 3 |
| A6 | Circular bus. models and knowl. base | 1 | 2 | 4 | 8 | 1 | 3 | 2 | 1 | 1 |
| A7 | Co-creation Lab Method./Program | 4 | 2 | 3 | 10 | 5 | 4 | 5 | 4 | 1 |
| A8 | EIC Summer School | 5 | 2 | 3 | 10 | 5 | 2 | 3 | 3 | 4 |
| A9 | EDIH Digital bus. development | 5 | 2 | 2 | 12 | 5 | 3 | 2 | 2 | 3 |
| A10 | ACCESS-3D printing e-learning | 4 | 3 | 4 | 12 | 2 | 3 | 5 | 2 | 2 |
| ... | ... | | | | | | | | | |
| A90 | Upcycling training modules | 1 | 2 | 5 | 8 | 3 | 5 | 4 | 3 | 1 |

Table 2: *Decision matrix (Source: authors)*

addition to its benefits regarding the use of qualitative data, this method was chosen as each criterion can be set with particular preference functions. In this study, authors have set, along with the usual criterion, the V-shape criterion or criterion with linear preference for C4 along with the p parameter – i.e. strict preference threshold. If the difference between the total number of competences is higher than 15, there is a strict preference threshold of one tool over the other, while if the difference between the total number of competences is lower that 15, the preference increases linearly. There are maximum 48 competences. The aforementioned has been done to allow us to emphasize significant differences in tool effectiveness when addressing people's competences. According to [34], the V-shape function is characterized by a strict preference threshold (p-value). Along with defining the preference function, the assessment of DGE tools was conducted, the first 10 tools and the 90th have been shown in Table 2.

C2 and C4 were measured numerically where the maximum DGE competence areas are 3 (C2) and there is a maximum of 48 competences that DGE tools/programs can address (consisting of 21 Digital, 12 Green and 15 Entrepreneurial and forming C4). Assessment of the DGE tools/programs per defined criteria was conducted by the authors in two phases: first individually and then in a group decision workshop. This approach was designed to reduce subjectivity and ensure consistency in evaluations. Authors assigned values from 1 to 5 values for descriptive criteria, where 1 signifies "very low", 2 "low", 3 "medium", 4 "high" and 5 "very high". For example, the timeframe flexibility of Go Startup (A1) is assessed as 1 indicating that it is fixed term program and not flexible and therefore assessed as very low.

Utilising the PROMETHEE II method (using Decision Lab 2000 software, version 1.01.0388), the 15 best tools were then selected based on their performance against the established criteria and their respective weights. The positive, negative and net flow along with complete ranking of the alternatives from the best to worst is presented in Table 3 and a short description of an optimal case for using the selected tools/programs is given on link.

## 4.2. Sensitivity Analysis

To assess the robustness of our findings, a sensitivity analysis was conducted focusing on both the weights assigned to each criterion and the V-shape criterion (C4). The weights for each criterion were changed to weights calculated from first 7 experts (w1=0.1417, w2=0.1080, w3=0.1283, w4=0.1289, w5=0.1248, w6=0.1124, w7=0.0955, w8=0.0902, w9=0.0703) to observe potential shifts in rankings of DGE tools/programs. Additionally, we varied the strict preference threshold associated with the V-shape criterion (C4) to evaluate its impact on overall rankings (by changing preference function ±20%). The PROMETHEE II method was reapplied after each adjustment, allowing us to document if there are any significant changes in ranking positions.

The results indicate that while several tools maintained their original rankings across differ-

ent scenarios, notable changes were observed for certain programs. For example, SmartCulTour Toolkit dropped from rank 3 to rank 4 when new weights were applied, indicating a relative decrease in effectiveness compared to other tools. However, when the weight of the V-shape criterion was decreased, it regained its rank of 3, demonstrating that its performance is more favorable under certain weighting conditions. Conversely, the University Green Digital Hub e-learning program experienced a significant shift, moving from rank 5 to 7 with new weights but rising back to 5 when the V-shape criterion was increased from 15 to 18.

| Tool/Program | Orig. model pos. flow | Orig. model neg. flow | Orig. model net flow | Orig. Rank | Rank-new weight | V-shape decr. rank | V-shape incr. rank |
|---|---|---|---|---|---|---|---|
| Google Grow tools | 0.55 | 0.14 | 0.41 | 1 | 1 | 1 | 1 |
| InnoSchool | 0.56 | 0.16 | 0.40 | 2 | 2 | 2 | 2 |
| SmartCulTour Toolkit | 0.51 | 0.13 | 0.38 | 3 | 4 | 3 | 3 |
| PoMP | 0.52 | 0.15 | 0.37 | 4 | 3 | 4 | 4 |
| University Green Digital Hub | 0.53 | 0.20 | 0.33 | 5 | 7 | 7 | 5 |
| Start Cup Veneto 2023 | 0.48 | 0.15 | 0.33 | 6 | 6 | 5 | 6 |
| DIH Tourism 4.0 | 0.56 | 0.23 | 0.33 | 7 | 8 | 6 | 7 |
| GoStartup Academy – Program Company | 0.52 | 0.19 | 0.33 | 8 | 5 | 8 | 8 |
| Sustainability management in companies | 0.51 | 0.21 | 0.30 | 9 | 9 | 9 | 9 |
| Life Cycle Assessment basic course | 0.49 | 0.21 | 0.28 | 10 | 11 | 11 | 10 |
| GoStartup Academy – Program Startup | 0.47 | 0.20 | 0.27 | 11 | 10 | 10 | 11 |
| SDG Identification | 0.44 | 0.18 | 0.25 | 12 | 12 | 12 | 12 |
| GostartUp - Video Masterclass | 0.45 | 0.22 | 0.23 | 13 | 13 | 13 | 13 |
| Popri Digital Video Course | 0.42 | 0.19 | 0.23 | 14 | 14 | 14 | 14 |
| Design Sprint 3.0 / Problem Framing | 0.52 | 0.19 | 0.21 | 15 | 15 | 15 | 15 |

Table 3: *Original preference flows and sensitivity analysis alternative rankings (Source: authors)*

These findings highlight the sensitivity of certain tools to changes in ranking criteria and emphasize the importance of considering both weight adjustments and preference functions in evaluating DGE tools and programs. Future analyses may benefit from further exploration of these dynamics to enhance decision-making processes.

## 4.3. Discussion

Following the analysis of the results, the selection of upskilling tools/programs aimed at enhancing DGE competences was presented to stakeholders and, upon review and approval, published online as its usefulness was projected to go beyond the international project partnership. Specifically, within this exercise, each tool/program has been evaluated for its effectiveness and

relevance, showcasing a diverse range of resources designed to support different aspects of DGE development.

As was expected, the list contained tools that were developed for a wide number of audiences, such as Google Grow Tools. This tool, ranked as number 1, stands out as a versatile learning material with a significant focus on improving business operations. With a 45% DGE competence rating (denoting the percentage of DGE competence areas it covers), this tool is broadly applicable and particularly valuable for startups and small to medium-sized enterprises (SMEs) as an accessible and cost-effective choice for those looking to boost their digital capabilities sustainably. The InnoSchool Tool, ranked as number 2, with a 55% DGE competence rating, is another tool of broad application, designed to raise awareness about social needs and improve the abilities and entrepreneurial skills of its learners, helping to build the next generation of social entrepreneurs and innovators. Based on the unique combination of a Serious Game, lectures, mentoring and reflection, with very positive user feedback, it succeeds in accumulating social entrepreneurship knowledge and skills. Ranked as number 3, SmartCulTour Toolkit (53% DGE competence) is an innovative resource intended for use in Living Labs, local communities, and policy-making contexts where stakeholder engagement is needed. The toolkit supports inclusive and sustainable development, making it a key resource for those working to drive sustainable projects. The analysis uncovered a portfolio of tools that are relevant to a diverse audience, including educational institutions, businesses, policymakers, and individuals (all relevant stakeholders within the project), seeking to enhance their DGE competences. Varied formats – ranging from digital learning programs and practical toolkits to entrepreneurial competitions – cater to project-relevant needs and international contexts. Being accessible, effective, and innovative, this tailored portfolio supports the development of crucial competences needed to advance in the digital and green transition, one of the main aims of the actions foreseen by the project.

Another important contribution of this study is the integrated viewpoint on the DGE competences, corresponding to the noted importance of the potential of digital technologies in addressing environmental and social challenges [17]. Namely, the top-ranked tools are the ones that demonstrate how technologies can be leveraged to enhance sustainability and entrepreneurship education, addressing more competence areas and supporting the holistic approach advocated by [29]; this integration is crucial as it reflects the interconnectedness of digitalisation, sustainability, and entrepreneurship, which are essential for achieving the SDGs, aligning well with recommendations of [38] in a call for speedier integration of sustainability into entrepreneurship programs and [32], who suggest that combining GreenComp and EntreComp is essential for the transition from system thinking to action.

With regards to the use of the PROMETHEE II in ranking and evaluating the upskilling tools and programs, it proved effective for building a custom-built and relevant portfolio by providing a robust basis for decision-making based on both quantitative and qualitative criteria, ensuring a balanced and comprehensive assessment. This paper thus complements well studies (given systematically in [40] that evaluate similar educational tools and programs (using MCDM) that enhance skills measured via well-established and complex competence frameworks. [6] in particular emphasised the complexity of developing entrepreneurial competence measurement scales. On that note, this study validated the usefulness of three well-known competence frameworks, both in the phase of self-assessment of experts and as categories/criteria listing competence areas that the tools/programs contribute to. The practical application of competence frameworks such as DigComp, GreenComp, and EntreComp was highlighted, demonstrating their effectiveness in real-world settings, supporting the work of [39], [8], and [5] who developed these frameworks to guide competence development in DGE areas. Additionally, the study provides practical insights into the operationalisation of these frameworks, as called for by [22]. The multi-purpose nature of these frameworks is evident, however, as [14] noted, the willingness to adopt and implement these frameworks among key stakeholders is crucial for

further development.

The practical implications of this study are significant for various stakeholders, including educational institutions, policymakers, and business support organisations. The ranked tools and programs provide actionable insights for designing and implementing upskilling initiatives, aligning with the recommendations of [18], who emphasise the need for higher resilience through enhanced competences. Individuals or organisations can adopt this portfolio of tools to enhance their curricula, policymakers can support the dissemination and adoption of these programs, and business support organisations can develop tailored training sessions to meet the specific needs of their clients. Also, the process outlined here in the paper can be followed to capture, curate and reuse tools/programs for other target groups and in different competence areas.

## 5. Conclusion

This study addresses the need for a holistic approach to sustainable entrepreneurship upskilling support. By using multiple competence frameworks in two distinct ways – as a competence self-assessment tool for experts engaged in MCDM exercise and as a mechanism to identify and categorise DGE upskilling tools/programs, the study contributes to a more comprehensive understanding of how to effectively upskill individuals in DGE areas. By ranking the 15 most useful DGE tools/programs for an international partnership with a diverse group of stakeholders, the study provides actionable insights into which tools are most effective in enhancing DGE competences. This ranking aids stakeholders in making informed decisions about which tools to adopt and promote, ultimately supporting capacity-building initiatives. PROMETHEE II was used as an effective tool for evaluating and ranking upskilling programs, ensuring also a comprehensive assessment of each tool's effectiveness. The practical application of competence frameworks such as DigComp, GreenComp, and EntreComp demonstrated their utility in real-world settings. The study highlights the potential for these frameworks to guide the development of effective upskilling programs that can be tailored to various educational and professional contexts.

There are several challenges and limitations to this study; in particular, the reliance on self-reported data from project partners may introduce bias, a concern echoed by [11] . Even if workshops and focus groups were organised to reach a common understanding and consensus, there is a need for objective and more critical perspectives in evaluating competence(s) areas. The subjective nature of qualitative assessments could affect the reliability of the rankings. The rapidly changing nature of digital and green technologies also means that the relevance of the identified tools and programs evolves over time, and while the GreenComp framework is rather novel and very flexible, as noted by [37], the DigComp is updated regularly, meaning the selected portfolio would need review accordingly.

While this study ranks tools and programs across various criteria, it does not explicitly assess their actual impact on learners' competence development, highlighting a need for future research to incorporate effectiveness data and post-implementation evaluations to provide a more comprehensive perspective.

Future research could focus on expanding the database of upskilling tools and programs to include more diverse geographical regions and industries, such as regions in Africa, Asia, and Latin America as foreseen by [3]. Additionally, there is a need to explore the impact of cultural differences on the adoption and effectiveness of these tools, whereby a study that would evaluate the performance of these tools with different global target groups can provide deeper insights into the relevance of this portfolio for upskilling in DGE competences.

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