**Appendices**

**Appendix A**

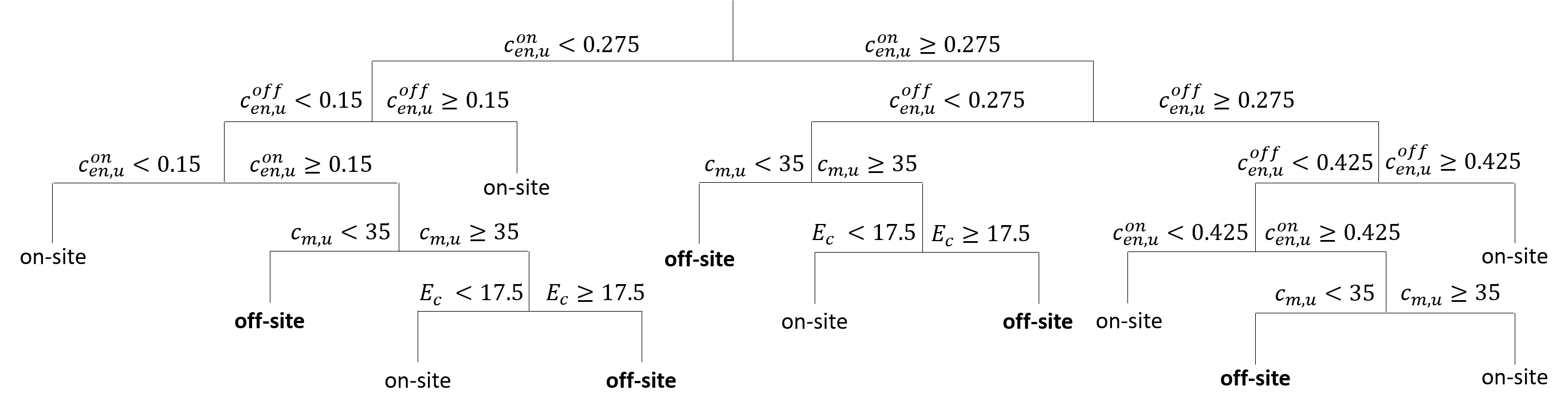
As discussed in the manuscript, an online workshop with practitioners working on AM and spare parts have been carried out to validate and ensure the correctness of the values adopted for developing the decision tree. Here (Table A1) we report the details of the practitioners who have participated in the online workshop (which lasted 1 hour).

|  |  |  |  |
| --- | --- | --- | --- |
| Expert ID | Position | Experience (Years) | Country |
| 1 | Head of Industrial Digital Division | 8 | Italy |
| 2 | Production Planner | 7 | Germany |
| 3 | Head of Logistics and Supply Chain Department | 11 | Finland |
| 4 | Head of Procurement Department | 8 | Denmark |
| 5 | Production Planner | 10 | Norway |
| 6 | Head of Supply Chain | 11 | The Netherlands |
| 7 | Head of Digitalization | 4 | Norway |

**Table A1.** Experts’ description

**Appendix B**

Here, for the sake of comparison with the decision tree developed considering both the economic and environmental terms, we report the decision tree developed considering only the economic term (Figure B1).

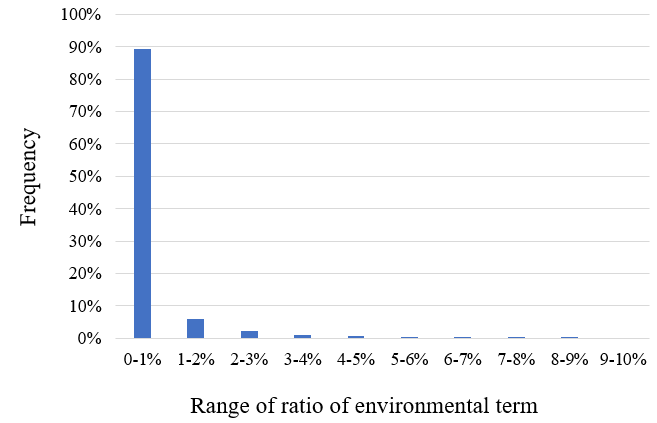


**Figure B1.** Decision tree for onsite/offsite AM production developed considering only economic terms

By comparing it with the decision tree reported in Figure 1, it can be seen that the two decision trees are identical.

**Appendix C**

Here we report the frequency distribution of the importance that the environmental costs (i.e. the environmental factor monetized through the carbon tax, ) over the total costs for the onsite AM production (i.e. ).

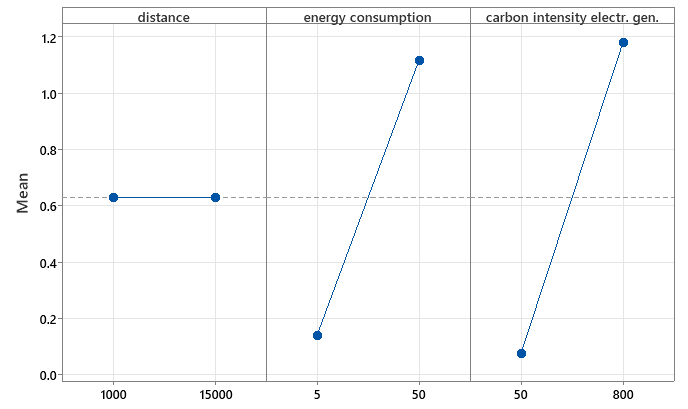


**Figure C1.** Frequency distribution of the ratio of environmental costs over total costs for onsite AM production (i.e. ).

As it can be seen by comparing Figure C1 with Figure 3, the results for the onsite and offsite configuration are basically the same: in both, the environmental costs represent at least 5% of the final total cost in less than 1% of the scenarios analyzed (specifically, 0.54% for the offsite and 0.50% for the onsite), and both have almost 90% of the scenarios analyzed where the environmental costs represent less than 1% of the final total cost (i.e., 89.4% for the offsite and 88.9% for the onsite).

**Appendix D**

As described above, the choice to use and as x- and y-axis derives from the results of the main effects plot analysis carried out to identify the input parameters that play a bigger contribution on the environmental term. The analysis has been carried out only for the offsite scenario as it is the one characterized also by the transportation phase. As it can be seen from Section 3.1, the variable input parameters that contribute to the environmental term are the energy consumption of AM machines, , the distance between the printing hub and the site of use, , and the carbon intensity of electricity generation, . Notably, in carrying out the main effects plot analysis we have assumed that the transportation occurs through airplanes as these lead to the highest CO2,eq emissions.



**Figure D1.** Main effects plot to identify the input parameters that play a bigger contribution on the environmental term.

**Appendix E**

In Table E1 we report the unitary energy cost, the carbon intensity of electricity generation, and the carbon tax of the homeland country (country A) of the Nordic energy company and of the countries where it operates (country B, …, country U). Moreover, in Table E2 we report the distance matrix between country A and the different host countries.

|  |  |  |  |
| --- | --- | --- | --- |
| **Country** | **Carbon tax (€/tonCO2,eq)** | **Unitary energy cost (€/kWh)** | **Carbon intensity of electricity generation (kgCO2,eq/kWh)** |
| A | 81 | 0.11 | 30 |
| B | - | 0.02 | 635 |
| C | - | 0.04 | 175 |
| D | 3 | 0.026 | 354 |
| E | - | 0.28 | 549 |
| F | - | 0.04 | 671 |
| G | - | 0.43 | 138 |
| H | - | 0.08 | 646 |
| I | 25 | 0.35 | 152 |
| J | 45 | 0.28 | 56 |
| K | - | 0.40 | 381 |
| L | - | 0.08 | 713 |
| M | 2 | 0.22 | 485 |
| N | - | 0.11 | 431 |
| O | 52 | 0.35 | 268 |
| P | - | 0.02 | 523 |
| Q | 4 | 0.22 | 471 |
| R | 15 | 0.24 | 174 |
| S | - | 0.07 | 349 |
| T | - | 0.13 | 639 |
| U | - | 0.13 | 475 |

**Table E1.** Details of countries considered

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Homeland** | **Host country** | | | | | | | | | | | | | | | | | | | |
| **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | **J** | **K** | **L** | **M** | **N** | **O** | **P** | **Q** | **R** | **S** | **T** | **U** |
| **A** | 2619 | 7626 | 12222 | 15939 | 3445 | 1085 | 7008 | 484 | 1338 | 835 | 5968 | 8389 | 7705 | 913 | 5634 | 10031 | 2384 | 8105 | 7652 | 8256 |

**Table E2.** Distance homeland (country A) – host countries (country B, …, country U)



**Table B2.** Distance matrix