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THE ROLE OF THE RESEARCH OF WOOD INDUSTRY WASTE AND BY-PRODUCTS IN H2020 PROJECTS

INTRODUCTION

The sustainable life cycle of wood products can play a key role in moving towards a low-carbon economy. Without it, meeting climate targets is unthinkable. Unfortunately, the sustainable production, consumption and recycling of wood products has received very little attention in international development programs in the past. This was due in part to unsustainable practices and in part to deceptive mass communication campaigns that have plagued the timber industry for decades, accompanied by extremely negative overtones.

Fortunately, there has been a positive shift in international development policy, public discourse, and international scientific life. A sustainable wood (industry) is becoming increasingly important in many disciplines. It is noteworthy that in 2018, the FAO, with the participation of several international organizations (ACSFI, CIFOR, ITTO, World Bank, WWF), announced the Sustainable Wood for a Sustainable World program [4], which seeks to support the growth of a sustainable wood industry in a complex way.

One of the most important elements for the success of a sustainable wood industry is the management of waste and by-products.

This study seeks to answer the question of whether the shift to the support of the management and research of waste and by-products of wood industry also appeared in Horizon 2020 at the European level.

Figure 1

Sustainable Wood for a Sustainable World

METHODS

The author converted the huge data files that can be downloaded from CORDIS [2], which contain tens of thousands of records and hundreds of thousands of related documents, into a relational database. This required several data conversions. The database provides an opportunity to examine data from all Horizon 2020 projects.

Keywords pre-filtered the wood industry projects. Then, the filtered file was content checked and the file was reduced further. Research projects related to waste and by-products were then filtered in a similar way.

The *Doctus* expert system was used to explore the hidden decision-making mechanisms for awarding grants, analyzing the supported projects using different statistical methods. Finally, the author also shortly analyzed the effectiveness of projects as measured by project outputs.

RESULTS

The change in attitudes of the various UN organizations has so far not registered in the European Union's development policy. Only 197 of the 30,084 Horizon 2020 projects (as of September 30, 2020) are to some extent related to the most widely understood wood industry production process (value chain). However, the connection is in most cases secondary, with up to a few dozen projects considered to be truly wood industry projects. All projects are, by definition, “sustainable”, as this is an essential indicator of success today. The target group,has only 92 research projects related to waste and by-products, which indicates the importance of recyclability.

The role of countries in the projects examined was characterized by five indices and the relationships between them:

1. *Number of project coordinator roles* associated with companies and institutions in each country.
2. *Number of project participations* related to companies and institutions in each country.
3. It was not examined independently, but we have taken into consideration the *production of roundwood* by country between 2013-2019 as an important factor in the analysis of the relationship between the criteria. Roundwood production is not a complex index, but it also indicates the size of a country's wood industry and the potential amount of waste and by-products. Examining exports and imports can also be important, but some of the waste and by-products are always related to extraction.
4. We calculated the *EU contribution per country* as an estimated indicator close to the real one.
5. We also calculated the *average EU contribution per project participation (per country)* in each country as an estimated indicator close to the real one.

For our last two calculated indicators, the EU contribution per project and the number of project participants were the basis for the calculation. We calculated the average contribution per project participant, and then we estimated the project contribution per country and the average contribution per project participation in each country. The result is somewhat different from the actual values, as the contribution awarded in the projects is not equal between the individual participants. However, for various reasons (e.g. lack of data), this was considered a good approximation.

Spain's leading role in the projects (Figure 1-2) is surprising. Spain is only 10th in the group of (EU and non-EU) countries surveyed in terms of roundwood production, and eighth in the EU countries surveyed. Export-import and several other production-trade factors do not change the fact that Spain does not play a leading role in the timber industry. [3]

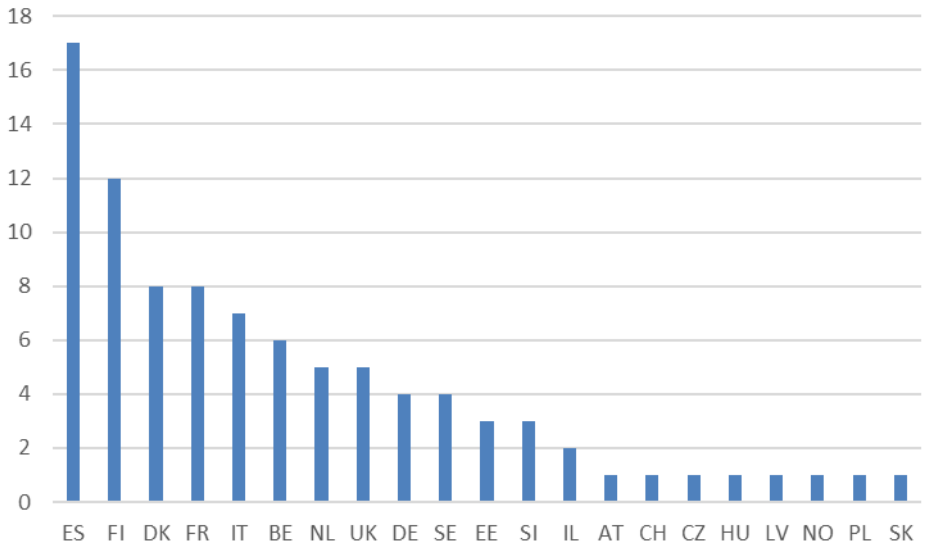


Figure 2

Number of project coordinator roles by country

However, the high number of project participations of Spain is mainly related to low-budget projects.

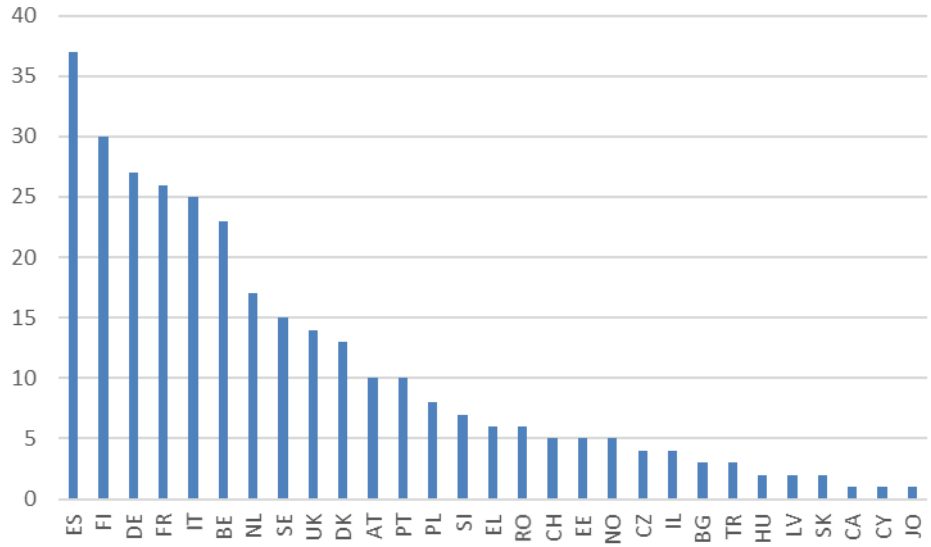


Figure 3

Amount of project participation by country

The real level of project contribution per country shown in Figure 4 may indicate an even greater difference in favor of the "old" EU Member States, based on the partial results of our calculations in a larger research. (This shows an estimated level.)

Figure 4 also shows that the leading position of Spain by the number of project coordinator roles by country and the number of project participations by country are not confirmed by financial contribution indices.

Finland is already in the lead here, ahead of Germany and Italy. Unfortunately, Hungary's role in these projects is rather small by all indices.

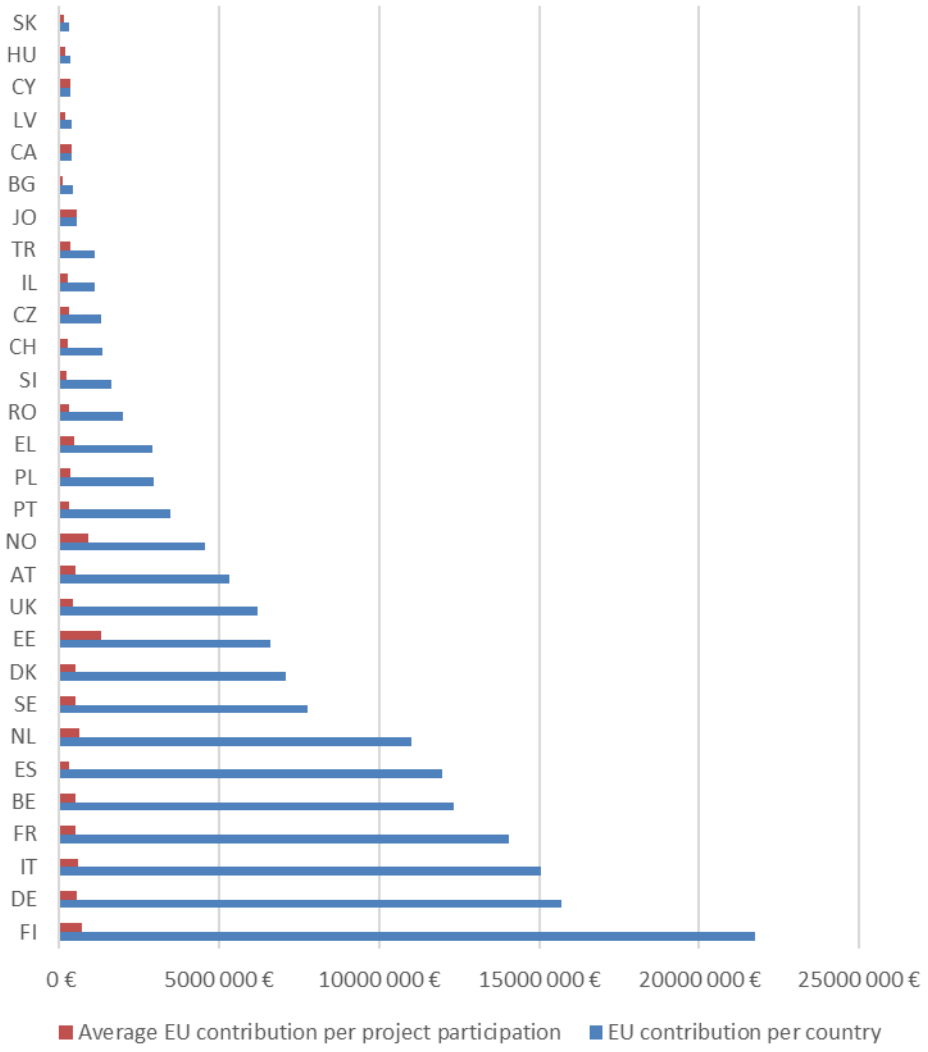


Figure 4

Financial indices

The relationship between the five criteria was characterized by Spearman's rank correlation coefficients [5]. (Table 1)

Unsurprisingly, based on the data in Table 1, the strongest rank correlation, 0.95, is between the number of project participations and EU contributions per country.

However, there is an almost neutral relationship between average roundwood production (2013-19) and other criteria.

This context should be treated with caution, as some of the participating countries are outside the EU, including some that are world leaders in the timber industry (e.g. Canada), but their participation in EU projects has been sporadic.

If we calculate the rank correlation coefficients for only the EU countries, we get a slightly different result. Table 2 shows that roundwood production here already shows a moderate rank correlation with some other criteria.

Table 1

Spearman's rank correlation coefficients (with non-EU countries)

CRITERIA	Number of project coordinator roles	Number of project participations	Production of roundwood (average, 2013-2019)	EU contribution by country	Average EU contribution per project participation by country
Number of project coordinator roles	1	0.78	0.16	0.76	0.39
Number of project participations	0.78	1	0.34	0.95	0.45
Production of roundwood (average, 2013-2019)	0.16	0.34	1	0.34	0.15
EU contribution by country	0.76	0.95	0.34	1	0.70
Average EU contribution per project participation by country	0.39	0.45	0.15	0.70	1

Table 2

Spearman's rank correlation coefficients (only EU countries)

CRITERIA	Number of project coordinator roles	Number of project participations	Production of roundwood (average, 2013-2019)	EU contribution by country	Average EU contribution per project participation by country
Number of project coordinator roles	1	0.80	0.28	0.78	0.55
Number of project participations	0.80	1	0.46	0.95	0.61
Production of roundwood (average, 2013-2019)	0.28	0.46	1	0.43	0.16
EU contribution by country	0.78	0.95	0.43	1	0.80
Average EU contribution per project participation by country	0.55	0.61	0.16	0.80	1

In the second phase of the research, we used the Doctus expert system to find the hidden decision rules behind the grant decisions [1]. So, we built a case-based knowledge base.

We mainly looked for the answer to whether there is a correlation between the contribution by participant received per project (as a decision variable), the country of the project coordinator and the distribution of project participants by country in the projects.

The decision problem is highly theoretical, as the amount applied for is already known when the applications are submitted. However, we believe that some sub-information can also be

extracted from this model. We were most interested in the country of the central "actors". The decision problem can also be interpreted as the question "What amount should we apply for?" But there are also limitations of this question too.

The 92 projects were arranged into four quartiles, based on the contribution per project participant. The we merged two quartiles (one original containing only one data) and created the three values of decision attribute**.** (Table 3).

Table 3

Simplified model of attributes

Attribute number	**Name**	**Values**	**Decision Attribute**	**Value Ordering**
Attribute 1	Evaluation	under median, medium high, high	Yes	Increasing
Attribute 2	Coordinator	Value 1…21: AT…UK	No	Nominal
Attribute 3-31	AT…UK (29 participant countries)	yes/no	No	Nominal

The values of the properties can be in different value order: *increasing* if the first value is the worst; *decreasing* if the best is in the first place; if one value is not better than the other, then the order is *nominal*.

If we build a case-based knowledge base; then after defining the properties and values, the collection of cases follows. We also need to provide an evaluation of the cases. Doctus will then find the rules that describe the cases of experience.

In case-based inferences, data mining is based on the idea that Doctus' rule-finding algorithm is also suitable for finding patterns in a database or data warehouse. Numerical data is first converted into symbols by the clustering algorithm, while non-numerical data is entered into the knowledge base as flexible values. The results of this type of data mining are easy to interpret - for an expert in the field.

So as a first step, we defined the attributes. (Figure 5)

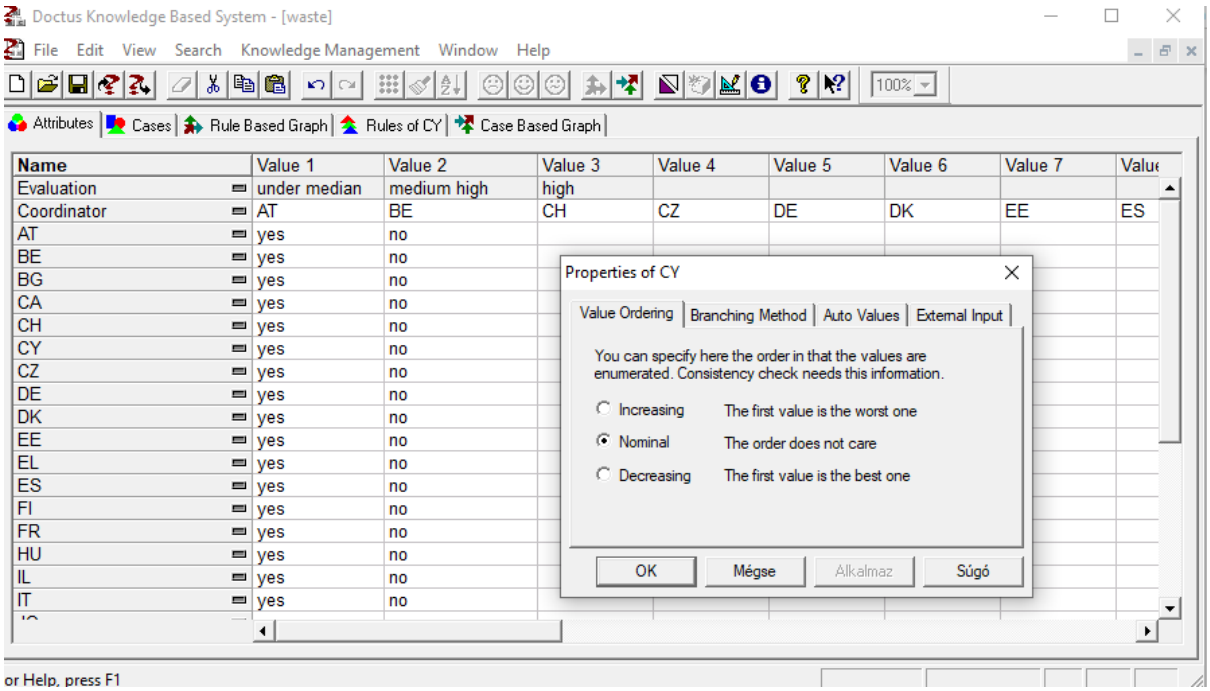


Figure 5

Attributes

Then, imported from Excel, we recorded all the cases and the 2,852 values associated with the cases and attributes. (Figure 6)

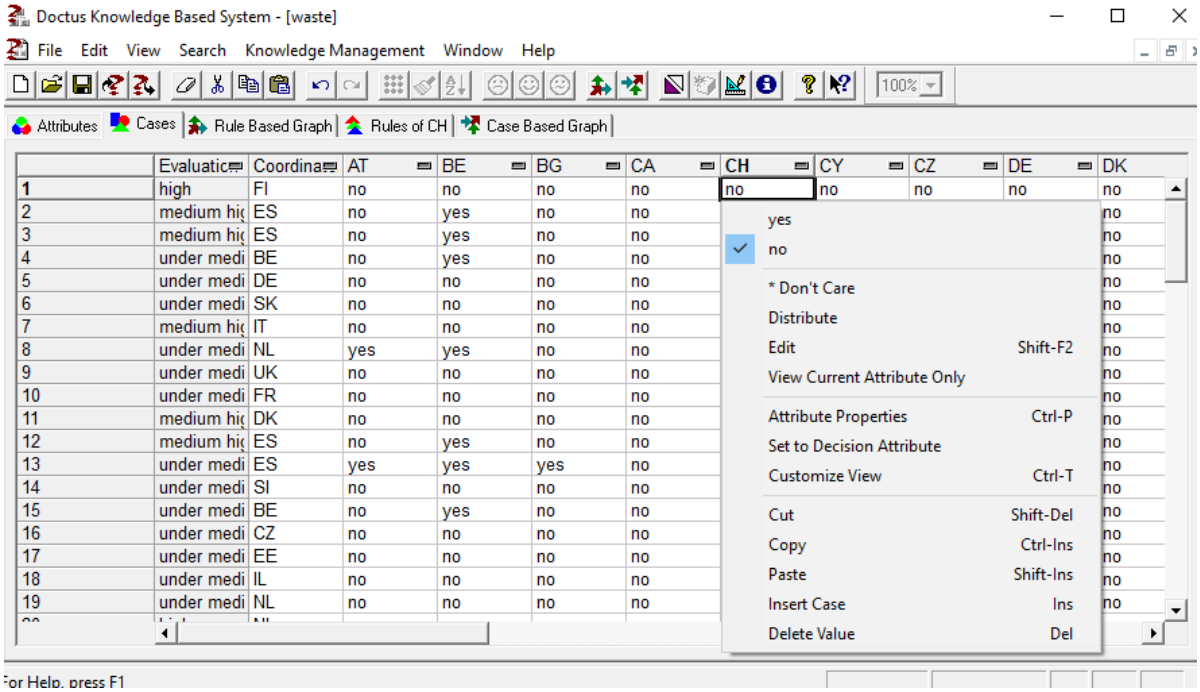


Figure 6

Cases

Doctus generates a case-based graph to classify cases collected from the expert. The case-based graph is a decision tree, but it does not show dependencies, but the "if ... then" rules that it derived from case processing. The "if ... then" rules can be read by moving from the root of the graph to the letters, where the value of the output is displayed.

When generating a case-based graph, you can choose from three branching modes. The default one is "*Efficient"*. The bipolar ("*Polar*") bifurcates each node into two groups of good and bad groups, classifying the values of the property. "*Heuristic*" gives the same result as an effective one if there are many cases and / or properties that would otherwise significantly increase the runtime.

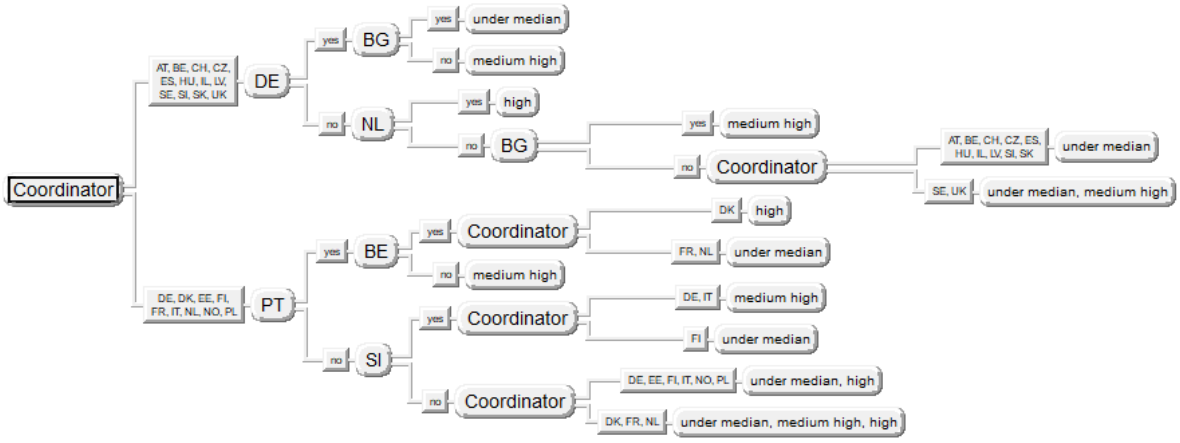


Figure 7

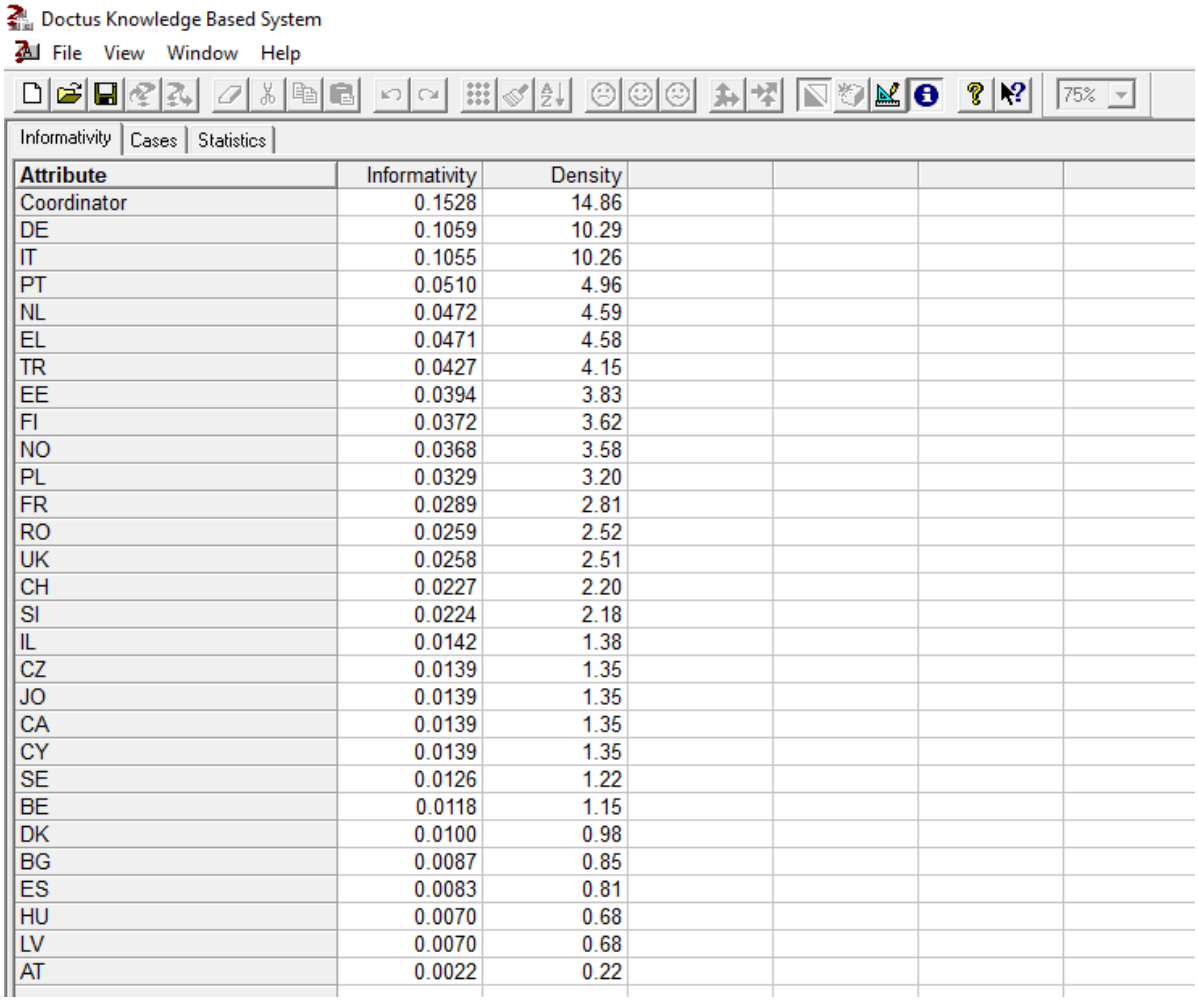
Cased-Based Graph

We could not select the most efficient modeling procedure ("Efficient") because it would have taken about 600 days to run it with the tools at our disposal. When applying the heuristic model, we obtained an overly diversified graph, so we used the "Polar" method.

The conclusion of the result is not necessarily interesting. It matters more what factors are most important.

Nodes are divided into branches based on the characteristics of the property selected for it. This distribution can only succeed if the case characteristics are not completely independent of the qualifying characteristic. The degree of this relationship is called *informativeness*.

The most informative attributes are the most determinant in decision mechanisms.



Attribute	Informativity	Density
Coordinator	0.1528	14.86
DE	0.1059	10.29
IT	0.1055	10.26
PT	0.0510	4.96
NL	0.0472	4.59
EL	0.0471	4.58
TR	0.0427	4.15
EE	0.0394	3.83
FI	0.0372	3.62
NO	0.0368	3.58
PL	0.0329	3.20
FR	0.0289	2.81
RO	0.0259	2.52
UK	0.0258	2.51
CH	0.0227	2.20
SI	0.0224	2.18
IL	0.0142	1.38
CZ	0.0139	1.35
JO	0.0139	1.35
CA	0.0139	1.35
CY	0.0139	1.35
SE	0.0126	1.22
BE	0.0118	1.15
DK	0.0100	0.98
BG	0.0087	0.85
ES	0.0083	0.81
HU	0.0070	0.68
LV	0.0070	0.68
AT	0.0022	0.22

Figure 8

Informativeness

In addition to the identity of the coordinator, the participation of German and Italian projects determined the value of the decision variable. German participation seems to have had a decisive and positive impact on the amount of the contribution, while the Spaniards involved in many projects play a peripheral role in the projects. (Figure 8)

In the third part of the article, we briefly outline a problem. Although the data are not yet final, the project results seem to involve a very high EU contribution (Figure 9), but this is basically the case for all projects, not just the study group. Most of the projects have not yet produced any project output. Of course, that may still change after 2020. Moreover, quantity and quality are not necessarily directly proportional.

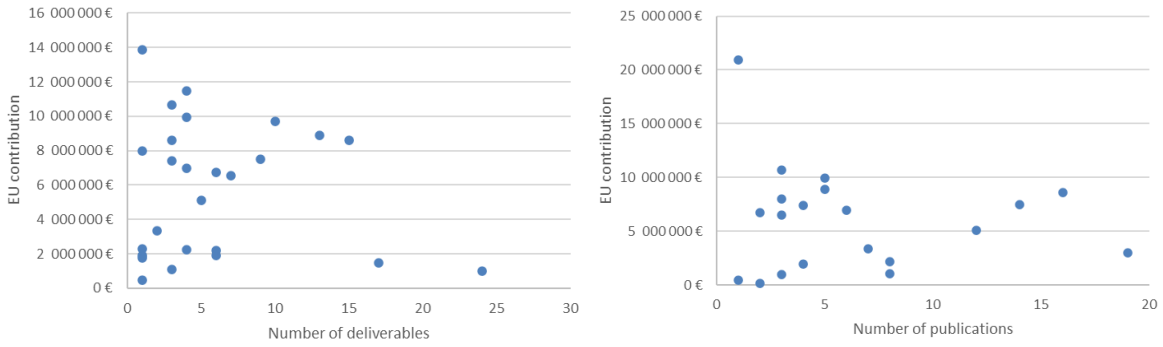


Figure 9

EU contribution and project outputs

CONCLUSION

Given the current, peripheral role of sustainable wood projects, it seems that the increasing trend at the level of large international organizations may reach the European Union in the next funding period.

Environmentally unfounded opposition to the wood industry may decrease in the future, and this process may be strengthened by sustainable wood industry projects. Therefore, the role of the management and research of waste and by-products of wood industry is very large. Higher added value and sustainability can be the way out of the serious structural problems of the Hungarian wood industry. For example, the University of Sopron may have a special role in the research of the necessary scientific foundations in the future. This obviously requires improving the conditions for local project management and increasing the interest of researchers in participating in international research projects through financial incentives.

However, based on Hungary's subordinate role so far, we must start from the realities. Following the Spanish example, smaller-than-average (but seemingly substantial) amounts should be targeted at joint projects where German participation is significant. The latter does not seem at all impractical given the economic and cultural ties between the two countries.

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