ACTIVITY 1.3

D.T.1.3.3

TML REPORT

FINAL VERSION **09/2020**

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Project Acronym	4STEPS
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Activity	Activity 1.3: Creation of a Technology Maturity Level index
Deliverable	D.T.1.3.3 TML Report
WP responsible partner	PP6- PBN
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Contributors	All partners

Introduction

In the framework of the previous activity of the project (namely D.T1.1.2) all in all 355 small and medium sized companies in seven different project regions underwent an analysis, through common questionnaire which focused on both their needs and their level of adaptation to I4.0 themes, so as to understand which interventions to implement out of catalogue tools. The common questionnaire was focusing particularly on the priorities of the national and regional plans, as regards the needs of SMEs, i.e. a correlation among the 9 technologies of Industry 4.0 (Big Data, Augmented Reality, Simulation, Internet of Things, Cloud Computing, Cyber Security, System Integration, Additive Manufacturing, Autonomous Systems) and their redefinition as regards needs, prospects and scenarios of RIS3 business sectors. Following the finalisation of SME involvement, every partner (LP+PP2 are working together) was preparing separate mapping reports (D.T1.2.1) based on the results of their own SME involvement in their regions, and apart from the separate country mapping reports PBN, as WPT1 Leader has prepared a Transnational Mapping Report based on the results on partnership level. Due to the country and transnational results, the involved companies can compare their results with other firms not only on country but on transnational level too.

In the framework of the D.T1.3.1 task of project, the partnership jointly developed and defined the TML (Transnational Maturity Level) index in order to evaluate the level of innovation of those companies which had taken part in the survey carried out in D.T1.1.3.
Following several discussions in the partnership, the TML has become a composite index, made up of six dimensions (*1: Related variety, 2: Human Capital, 3: Project Management; 4: Research and development; 5: Breadth of Industry 4.0; 6: Depth of Industry 4.0*) and all of these six dimensions are measured as percentages. Thus, the overall TML are expressed in percentages as well, being it a simple average of six dimensions expressed in percentages. There was a calculation rule for each dimension, specifying which question(s)' answers had to be taken into account when calculating a separate dimension. (Further details of the calculation can be found in the supporting materials, already uploaded under D.T1.3.1) Similarly to the information found in the mapping reports, the TML indexes (including the six dimension results) can be considered as an objective information to the involved companies to compare their results with firms on national and transnational level as well.

The result of the six dimensions as well as the overall TML index of all companies involved in the survey can be checked here on CRM: *https://4stepscrm.com/index.php*

Log in with country admin account→ Questionnaires→Questionnaire statistics→TML index;

(The credentials of PBN as WP Leader (and main administrator of the system) are the following:

username: martin.dan@pbn.hu

Password: aA123456)

TML applied to all the 4STEPS sample

Based on the TML results visible on the CRM, average percentage results have been calculated to each dimension, using the whole 4STEPS company sample results. As Figure 1 reflects, the Research and Development index has the lowest average result, when we take into consideration every company (in total: 355) which had taken part in the survey. Figure 1 also shows that the Depth of Industry 4.0 dimension has the highest average result, which is almost double as the average R&D index result.

However, it has to be emphasised that these average figures correspond to different behaviours and strategies in each region.

The ***Related Variety index*** was examining companies' activity in economy sectors and asks respondents to mark down all the sectors in which their firm is operating along with all the sectors in which its customers and suppliers are operating as well.

The ***Human Capital index*** was calculating how many employees are currently employed in R&D offices and technical offices and, among them, how many have a tertiary education background.

The ***Project Management index*** measured whether the firm has participated in funded research projects. It is based on multiple choice answer so that the firm could participate in no projects at all or in EU, national and/or regional projects.

The ***Research and Development index*** was based on a multiple choice answer as well. In this case the scrutiny was how many different types of R&D activities/collaboration the firm has undertaken, with the possibility to mark down up to nine given alternatives.

The ***Breadth of Industry 4.0 index*** was calculated from the replies where companies were indicating which Industry 4.0 technologies they are dealing with currently, at least to a few extent.

The result of the ***Depth of Industry 4.0 index*** has come from the answers where companies were indicating to what extent (few; good, intense) they are currently using the listed I4.0 pillars.

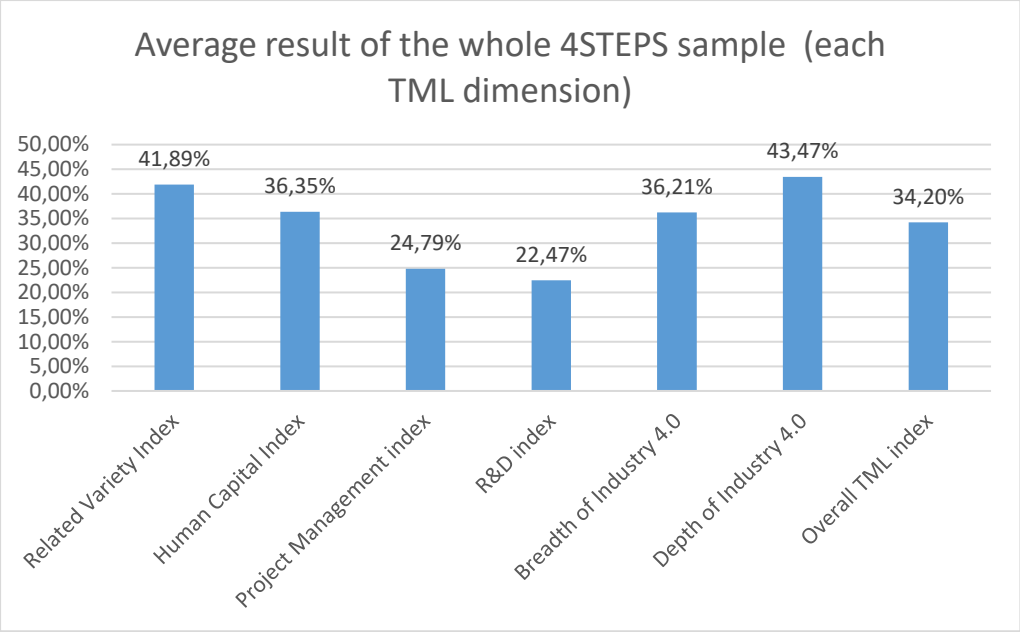

Figure 1: Average result of the whole 4STEPS sample (each TML dimension)

Report for each region

Following the integration of the joint TML index to the CRM system, partners were asked by PBN (WPT1 Leader) to choose the companies (10 companies per country, so 70 companies all together) to which the TML would be applied. The criteria to select the 10 pilot companies was left open to each partner, but it was important that each partner explicitly motivated its choice, criteria and motivation.

In order to support the partners on how to choose their 10 companies, CNA (LP) and RE:Lab partners (PP2), in strong collaboration with PBN (WPT1 Leader; DEXIC as WPT2 Leader and FHV as WPT3 Leader) elaborated and provided a short guideline to the partnership. This guideline has been also integrated in the report.

As soon as partners sent the names and the TML indexes of their 10 companies, further calculations were carried out measuring the average TML indexes of the chosen 10 pilot companies. Following this, the average TML indexes of the chosen 10 pilot companies were compared to the average TML of the whole 4STEPS sample (seen the overall results in Section 1).

In order to visualise this comparison, radar graphics have been prepared to illustrate the difference between the average TML indexes of the chosen 10 pilot companies, and the whole 4STEPS sample. These graphics shall be listed and explained below separated by country. On every listed graphic the blue colour means the results of the whole 4STEPS sample - it is the same on every graphic - whereas the orange colour will indicate the regional result of the country.

ITALY (CNA & RE:LAB partners)

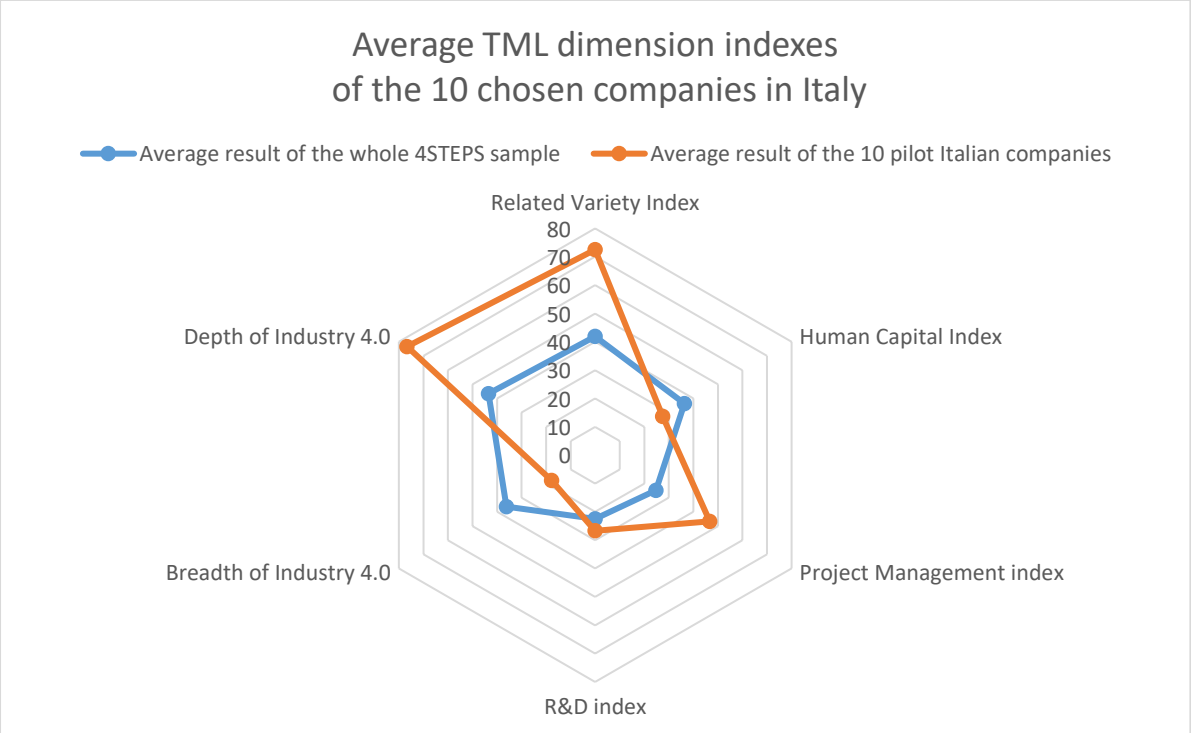

Figure 2

Figure 2 demonstrates that the average TML result of the 10 chosen Italian companies is a lot higher in the Related Variety and Depth of Industry 4.0 dimension and higher in Project Management dimension than in the whole 4STEPS sample, whereas the Human Capital and Breadth of Industry 4.0 results are lower than the whole 4STEPS average. The R&D index is almost the same in the Italian and whole 4STEPS sample average as well. If we count all dimensions together it can

be stated that the whole TML index (average of the separate dimensions) is higher in the 10 Italian companies than in the entire project sample 44.63% versus 34.2%.

The results and Figure 2 also suggest that the chosen 10 Italian companies' and their suppliers' and customers' economic sectors are diversified and they are operating in different areas, this is the result of the relatively high average Related Variety result which is 72.5%. In contrast, the result in Human Capital dimension is lower than the 4STEPS sample which might mean that the chosen Italian companies either do not have R&D/technical offices or the number of employees with tertiary education in these offices is not high. Figure 2 also reflects that the chosen Italian companies are rather active in project participation, compared to the whole project sample. It can be also read from the figure that the collaboration with R&D actors is almost on the same level in the chosen Italian companies as in the entire project sample. Regarding the current usage of Industry 4.0 technologies, the figure shows that the majority of the chosen Italian companies are using just 1-2 such technologies, but those firms who are using these technologies, their level of extent is rather high.

POLAND (ARRSA)

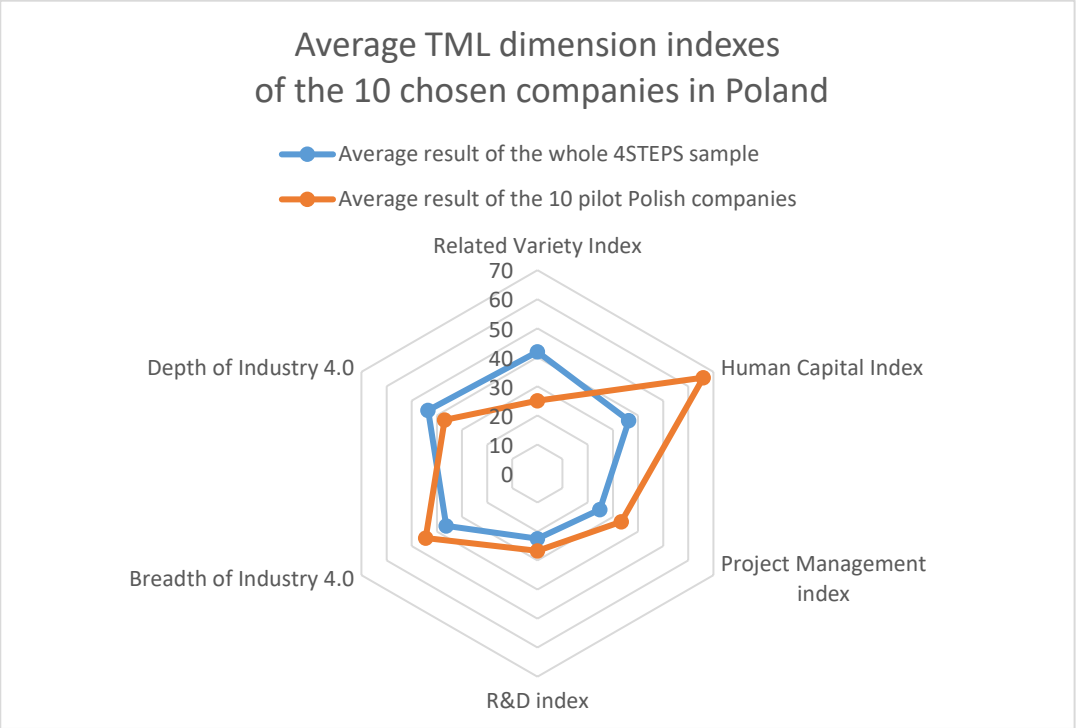

Figure 3

As far as the Polish TML dimension results are concerned, Figure 3 illustrates that the results of the 10 companies chosen by ARRSA partner is relatively similar to the average of the project sample average. What is outstanding in the Polish result is the high (65.98%) Human Capital index, which might mean that the chosen Polish companies have R&D/technical offices where colleagues with tertiary education are employed mainly. In contrast, the average Related Variety index of the chosen 10 Polish companies is weaker than the project average which might indicate that the economic sectors of the chosen Polish companies' their suppliers and customers are not so diversified. The average result of the other four dimensions is roughly the same at Polish companies and project sample average, which means that the 10 Polish companies are operating on an average level in Project Management, R&D index as well as Breadth/Depth of industry 4.0. Since the separate dimension results of the Polish companies as well as the project sample are approximately the same, there is no big difference in the overall TML indexes either (38.72% versus 34.2%)

AUSTRIA (FHV)

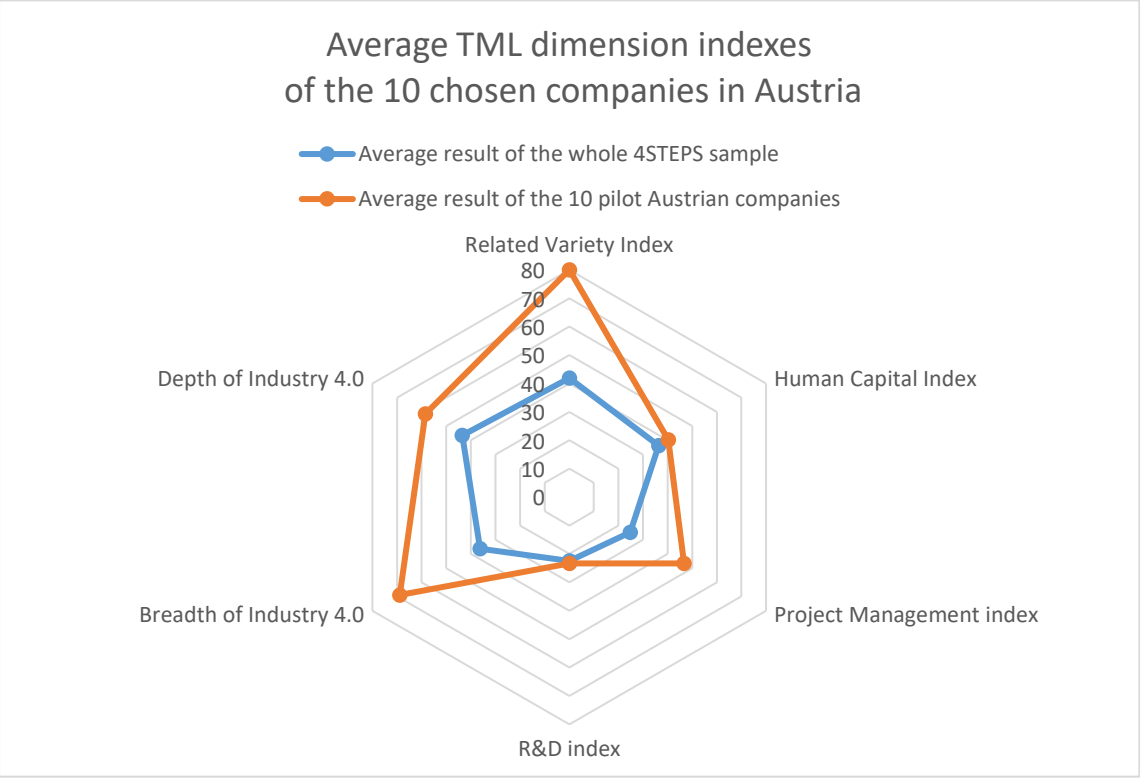

Figure 4

When it comes to Austrian results, Figure 4 obviously illustrates that the chosen Austrian companies' TML index result is at least on the same level, but mainly above the entire average project sample. Regarding the Related Variety index, Figure 4 depicts that the chosen Austrian companies (suppliers and customers) are more diversified in economic sectors than the project sample companies. Human Capital and R&D index are correlating and Figure 4 shows that the chosen Austrian companies on average are approximately on the same level than companies involved in the survey on project level. Regarding the interaction with enabling technologies, Figure 4 reflects that the chosen Austrian companies are rather strong in the usage of Industry 4.0 pillars as well as the extent of usage of these technologies at firms is rather high as well. When the overall TML results are compared the difference is also remarkable (52.93% at the 10 chosen Austrian companies versus 34.2% at project average).

CZECH REPUBLIC (DEXIC)

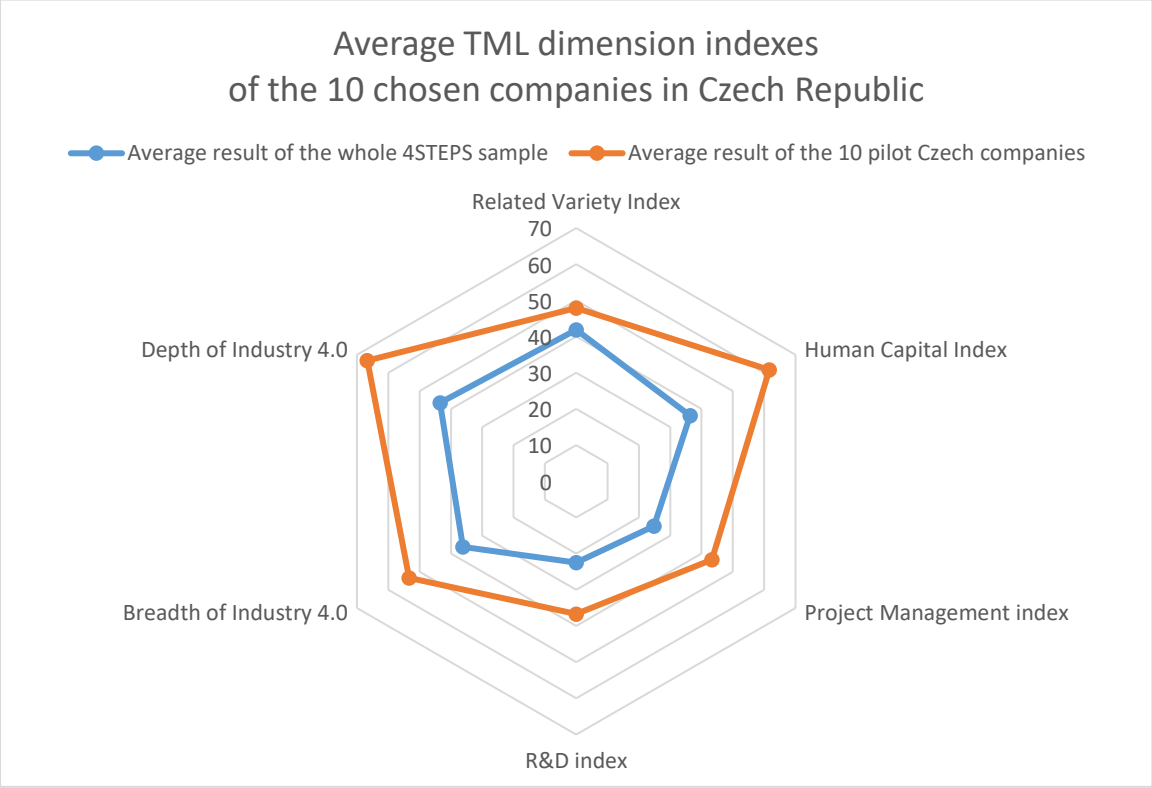

Figure 5

Figure 5 clearly reflects that the average result of the chosen Czech companies is higher at every dimension than the average result of the entire project sample. The most outstanding difference

between the two average results can be seen at Human Capital index, but the difference is also remarkable at Breadth and Depth of Industry 4.0 indexes as well. These high results might indicate that the majority of the chosen Czech companies have R&D/technical offices with relatively high number of employees with at least BsC degree. Figure 5 undoubtedly demonstrates that the chosen Czech companies are strong in the usage and level of I4.0 technologies as well, which means that several firms are currently using such technologies in a high level. It can be seen on Figure 5 that project participation and collaboration with R&D institutions are also playing important roles at the chosen Czech companies. Since every average dimension result is higher at Czech companies, as a result the entire TML index is higher than the 4STEPS sample average (52.41% vs 34.2%).

HUNGARY (PBN)

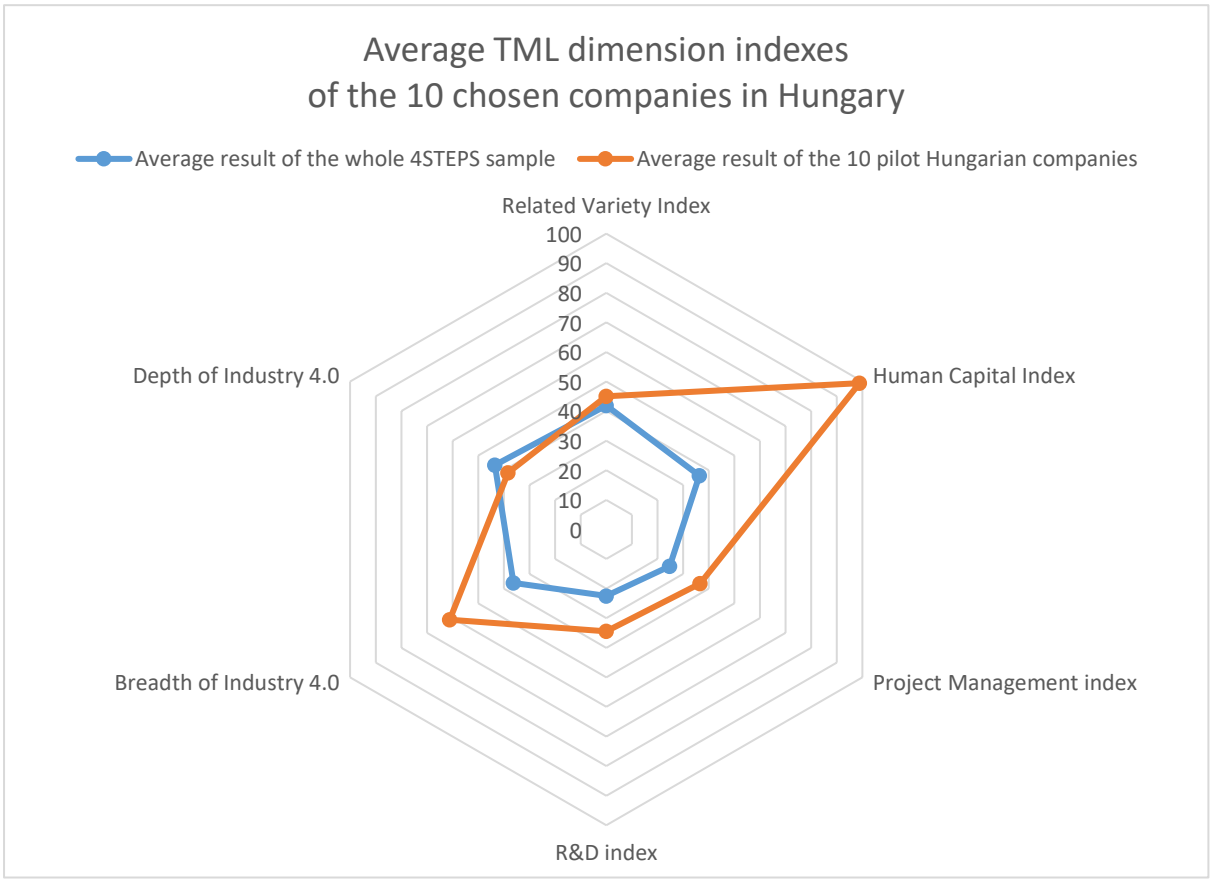

Figure 6

Figure 6 reflects the average TML dimension results of the 10 chosen Hungarian SMEs. The most surprising data from the figure is that the Human Capital index of the chosen Hungarian SMEs is extremely high, which might mean - based on the dataset - that the

chosen Hungarian SMEs have a well-built R&D/technical office with high number of employees with tertiary education. Regarding the average results of the other dimensions no outstanding data can be seen. The figure shows that the chosen Hungarian companies is a bit more active in project participation and their cooperation with R&D actors is also a bit higher than the total companies' average data on partnership level. As far as the interaction with enabling technologies is concerned, Figure 6 presents - at Breadth/Depth of Industry 4.0 dimensions - that the chosen Hungarian companies are currently using few I4.0 technologies, but the level of their usage is not so intense. The Figure also has shown that the chosen Hungarian companies suppliers and customers are approximately as diverse in economy sectors as the firms in the whole project sample.

SLOVENIA (CCIS)

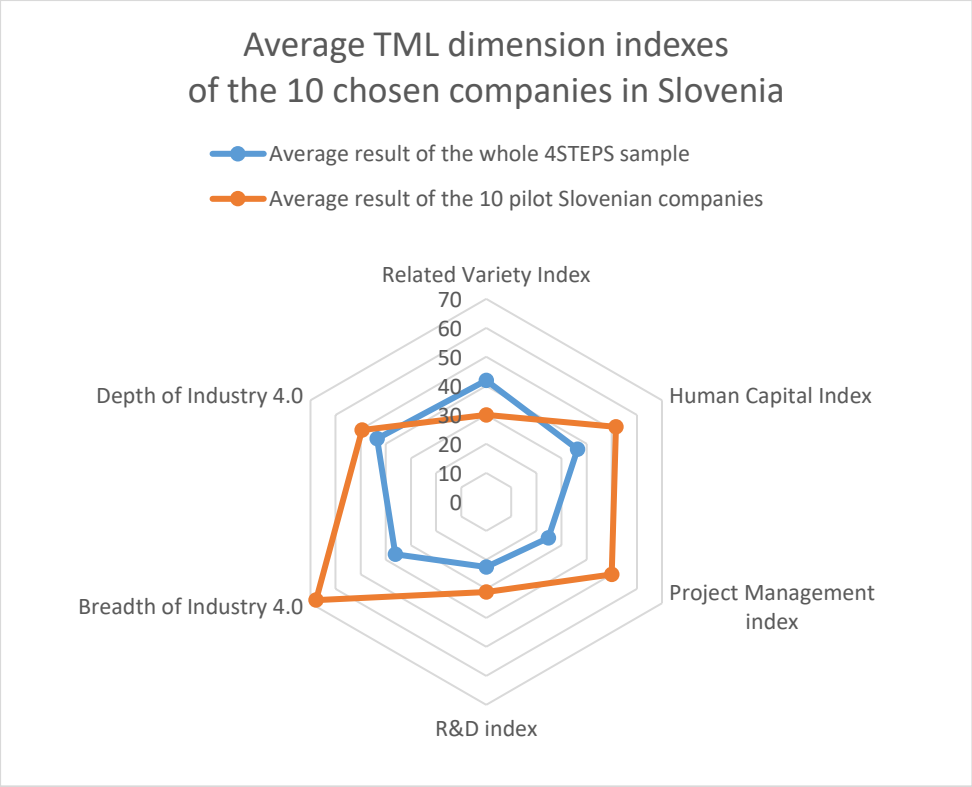

Figure 7

Figure 7 reflects the comparison between the average result of the chosen 10 Slovenian SMEs and the average result of the whole project sample. When we scrutinise the separate

dimensions, it can be seen that except the Related Variety index, every average dimension of the 10 Slovenian firms is higher than the 4STEPS sample in total.
The most outstanding result can be seen at the Breadth of Industry 4.0 dimension, which might indicate that the majority of the chosen Slovenian companies are currently dealing with the most I4.0 technologies, but their extent of usage is not remarkably high. Besides, Figure 7 also demonstrates that the chosen Slovenian companies are more active in project participation on average than the companies involved in the project.

GERMANY (VDC)

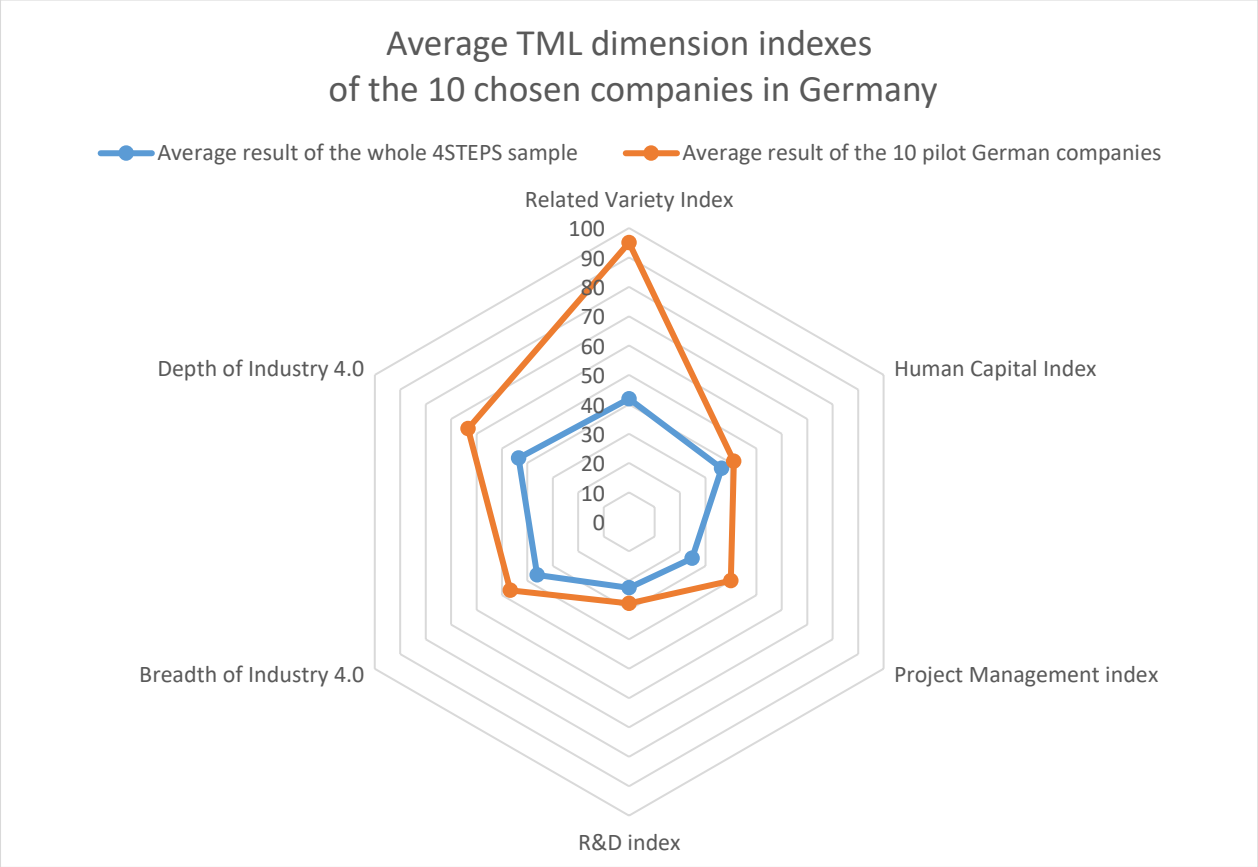

Figure 8

The average results of the chosen German companies are visible on Figure 8. The most outstanding result is the extremely high number of the Related Variety dimension, which might indicate that the chosen 10 German companies as well as their suppliers and customers are operating in different economy sectors. The Human Capital and R&D index

average of the 10 German companies are roughly the same as the 4STEPS project average, but as Figure 8 illustrates the chosen German companies are more active in project management than the overall average. As far as interaction with enabling technologies is concerned, every chosen German SME is currently dealing with at least one Industry 4.0 technology (but the majority of the firms are dealing with more), but the figure illustrates that their level of extent usage is rather high.

Conclusion

As the figures and the short explanation above reflect, there are some similarities in the level of TML dimensions at each country's results, but there are some outstanding results as well.

The following table will show the main conclusions and differences of the analysis regarding the comparison between the average TML result of the 10 chosen companies and the average TML result of the whole 4STEPS sample. Table 1 reflects that the majority of the outstanding differences were positive, which means that the average percentages of the 10 chosen companies of the region were significantly higher than the average percentage of the whole 4STEPS sample.

When we separate the average results the summary of Table 1 shows that the Related Variety dimension average result is a lot higher for the 10 chosen Italian and German companies than in the overall 4STEPS sample, whereas this average dimension result is lower in Poland and Slovenia.

Table 1 is reflecting that the chosen 10 Polish, Czech and Hungarian SMEs' average results at Human Capital dimension are remarkably higher than the whole project average.

Regarding Project Management dimension, Table 1 reflects that the chosen Italian, Austrian, Czech and Slovenian companies are more active in projects than the whole 4STEPS project average.

Table 1 does not consist Research and Development dimension which means that there is no significant difference between the regional average and the whole project data at this dimension.

Regarding the Breadth of Industry 4.0 dimension - usage of I4.0 technologies -, Table 1 illustrates that in Austria, in Czech Republic, in Hungary, and in Slovenia the average result is higher than the project sample average, while in Italy this happens on the other way round: the value of this dimension is rather low compared to the project average.

When we scrutinise the Depth of Industry 4.0 dimension - extent of usage of I4.0 technologies - Table 1 summarises that the average result of companies chosen by Italian, Austrian, Czech and German partners is higher than the 4STEPS average, so it means that on average these companies are dealing with I4.0 technologies in a bigger extent than the firms involved in the partnership.

Country	TML Dimension	Average % of the whole 4STEPS sample	Average % of the 10 chosen companies of the region
ITALY	Related Variety	41.89%	72.5%
ITALY	Project Management	24.79%	46.67%
ITALY	Breadth of Industry 4.0	36.21%	17.78%
ITALY	**Depth of Industry 4.0**	43.47%	76.67%
POLAND	Related Variety	41.89%	25%
POLAND	Human Capital	36.35%	65.98%
AUSTRIA	Related Variety	41.89%	80%
AUSTRIA	Project Management	24.79%	46.67%
AUSTRIA	Breadth of Industry 4.0	36.21%	68.89%
AUSTRIA	**Depth of Industry 4.0**	43.47%	58.45%
CZECH REPUBLIC	Human Capital	36.35%	61.64%

CZECH REPUBLIC	Project Management	24.79%	43.33%
CZECH REPUBLIC	Breadth of Industry 4.0	36.21%	53.34%
CZECH REPUBLIC	**Depth of Industry 4.0**	43.47%	66.67%
HUNGARY	Human Capital	36.35%	98.89%
HUNGARY	Breadth of Industry 4.0	36.21%	61.11%
SLOVENIA	Related Variety	41.89%	30%
SLOVENIA	Project Management	24.79%	50%
SLOVENIA	Breadth of Industry 4.0	36.21%	67.78%
GERMANY	Related Variety	41.89%	90%
GERMANY	**Depth of Industry 4.0**	43.47%	63.34%

Table 1