Education on digital skills and standards

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Three levels of digital divide

The gap between individuals, households, businesses and geographical areas at different socio-economic levels with regard both to their opportunities to access technologies and their use of technologies for a wide variety of activities.

Following van Deursen, Helsper (2015), Ragnedda and Ruiu (2017), Ragnedda,Kreitem (2018), Gómez (2018), van Dijk (2020), Robinson et al. (2020), Aydin (2021) etc.

- Physical access
- Skills access (Usability divide)
  - Medium-related skills : operational or instrumental skills needed to command ICT and digital media
  - Content-related skills : geared toward finding information, communicating, acting, and creating
- Usage access / Benefits (Empowerment divide)
  - Frequency of use, Time spent, Ability to transform Internet access and skills into favourable offline results

Standards in digital literacy and education can help reduce the digital divide by ensuring that people have the necessary skills to use digital technologies effectively

Employee´s skills as a driver to a company satisfaction – an eventual key to a satisfaction of the society

- Challenges to adoption of technologies, such as a **lack of available expertise** (Bello et al., 2021; Kamble et al., 2018)
- Borrageiro and Mennega (2023) : review concerning **expertise needed for digital transformation**, and four main categories of skills are identified: soft skills, social skills, methodological skills, and hard skills
- Our focus : firms' satisfaction with the skills available - adoption of various emerging technologies (like AI)

Based on: Huňady, J., Lacová, Ž., Vallušová, A.: Firms' satisfaction with their competencies in the era of artificial intelligence and emerging technologies: Who is missing IT and data analytic skills? 26th Annual Conference of the International Network for Economic Research, Chania, Crete, Greece, 18-20 June 2024

Questions to explore

- Are those **firms using emerging** technologies more satisfied with their employees' IT and data analytic skills?
- Do more extensive **employee upskilling programs** impact a company´s satisfaction with the skills of its workforce?
- How does **industry** and **country** influence firms' satisfaction with employees' skills?

Data description

Firm-level microdata collected for the **Advanced Technologies for Industry** (ATI, 2020)

Country	No. of observations	Industry	No. of obs.	Size	No. of obs.
France	311	Financial services	171	10-249	464
Germany	303	Government/Education	167	250-499	334
Italy	279	Healthcare	130	500-999	345
Poland	165	Manufacturing - discrete	120	1000+	404
Spain	281	Manufacturing - process	154		
Denmark	80	Professional service	187		
Sweden	128	Retail/Wholesale	161		
		Telecom/Media	116		
		Transport/Logistics	130		
		Utilities, Oil, Gas	111		
		Agriculture	100		

Firm´s satisfaction

Variable	Question/Description	Coding
General IT skills (satisfaction)	How satisfied are you with the general IT skills available in your company?	1 - Very dissatisfied 2 - Rather dissatisfied 3 - Neither satisfied nor dissatisfied 4 - Rather satisfied 5 - Very satisfied
Professional IT skills (satisfaction)	How satisfied are you with the professional IT skills (e.g., programming) available in your company?	
Numerical and data analytics skills (satisfaction)	How satisfied are you with the numerical and data analytics skills available in your company?	

Technologies

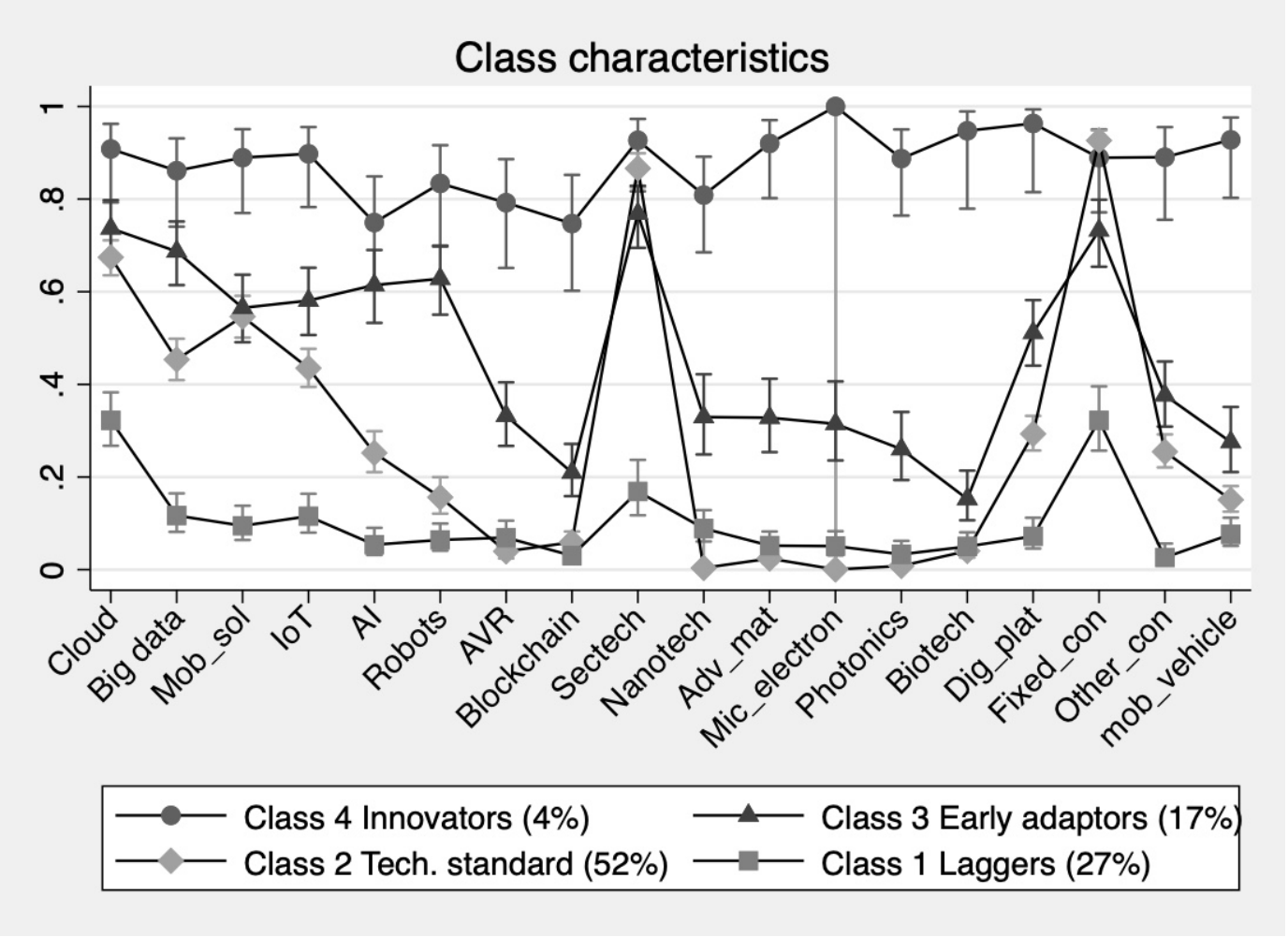
	Percentage of Users
Public cloud	59.92
Big data and analytics solutions	41.95
Mobile solutions that allow access to a business process or IT system via internet-enabled mobile devices	44.09
Internet of things (IoT) solutions	39.24
Artificial intelligence (AI) Systems	28.18
Robotics	24.11
Augmented and virtual reality	12.86
Blockchain	10.47
Security technology solutions	66.26
Nanomaterials – excluding micro and nano electronics	11.57
Advanced materials	12.02
Micro and nanoelectronics – excluding nanomaterials	10.86
Photonics	9.37
Industrial biotechnology	9.83
B2B industrial digital platforms	29.80
Standard connectivity - fixed or mobile voice or data	72.72
Advanced connectivity - short range wireless (e.g., Zigbee, 6LoPAN), Satellite, LPWAN (e.g. NB-IoT, LTE-M, Sigfox, LoRA)	23.92
Vehicle-related mobility IT solutions	18.29

Different technological levels of the firms

Results

of the Latent Class Analysis

Class 2 tech standards: cloud, mobile solutions, sec-tech and fixed connectivity



Relevance of general IT skills through the classes

	How relevant are the following skills when considering the implementation of advanced technology-based products and projects? **General IT skills**					
Technology usage	1 Not at all relevant	2	3	4	5 Extremely relevant	Total
Class 1: Laggers	7	53	159	143	34	396
%	1.77	13.38	40.15	36.11	8.59	100
Class 2	10	49	162	432	189	842
%	1.19	5.82	19.24	51.31	22.45	100
Class 3	1	14	55	110	69	249
%	0.40	5.62	22.09	44.18	27.71	100
Class 4: Innovators	0	2	8	17	33	60
%	0.00	3.33	13.33	28.33	55.00	100
Total	18	118	384	702	325	1547
%	1.16	7.63	24.82	45.38	21.01	100

Relevance of professional IT skills through the classes

	How relevant are the following skills when considering the implementation of advanced technology-based products and projects? Professional IT skills (e.g., programming)					
	1	**2**	**3**	**4**	**5**	**Total**
Class 1: Laggers	13	76	156	113	38	396
%	3.28	19.19	39.39	28.54	9.60	100
Class 2	25	180	281	234	122	842
%	2.97	21.38	33.37	27.79	14.49	100
Class 3	0	24	77	91	57	249
%	0.00	9.64	30.92	36.55	22.89	100
Class 4: Innovators	2	2	6	16	34	60
%	3.33	3.33	10.00	26.67	56.67	100
Total	40	282	520	454	251	1547
%	2.59	18.23	33.61	29.35	16.22	100

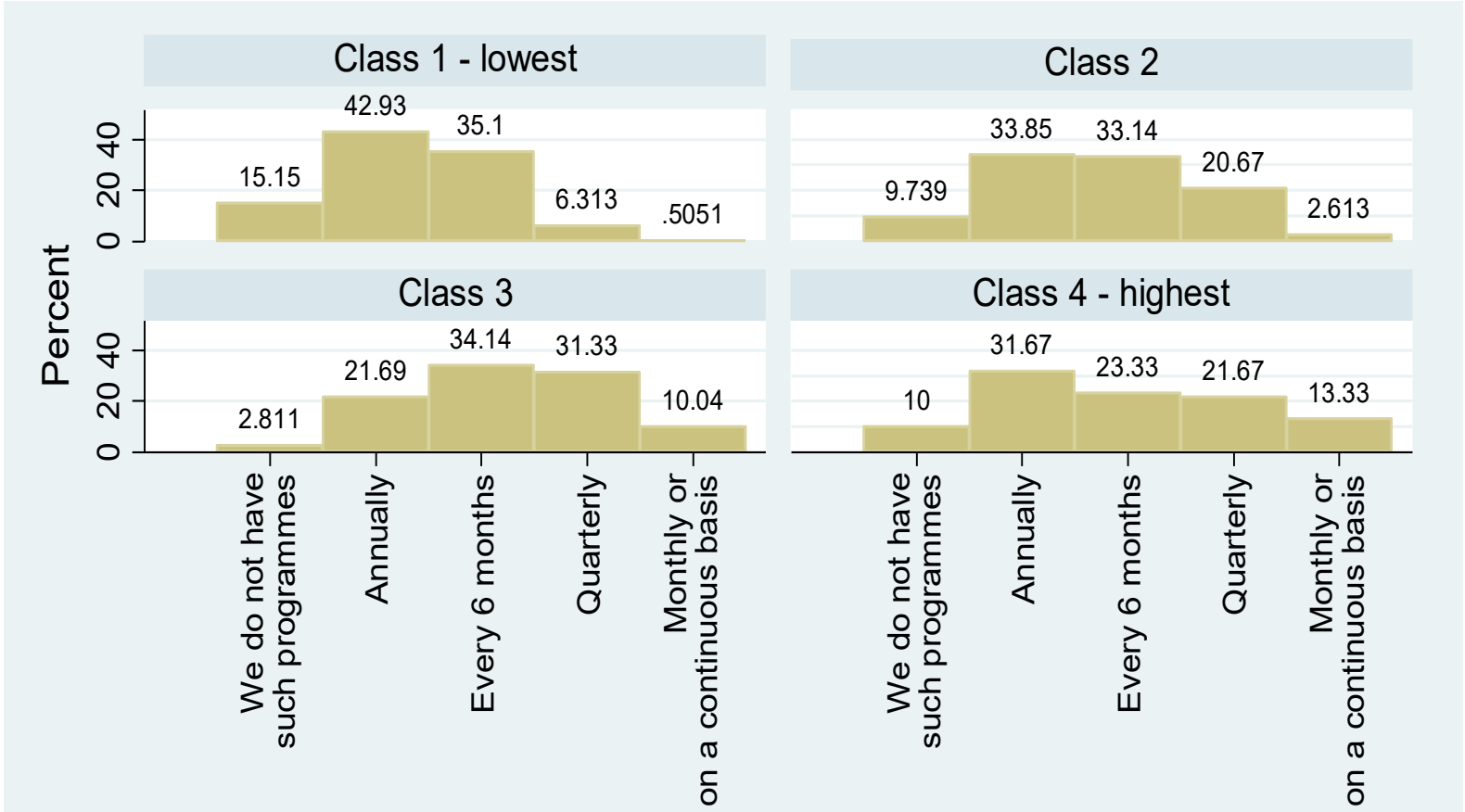
Relevance of numerical and data-analytics skills through the classes

	How relevant are the following skills when considering the implementation of advanced technology-based products and projects? **Numerical and data analytics skills**					
	1	**2**	**3**	**4**	**5**	**Total**
Class 1: Laggers	23	80	148	115	30	396
%	5.81	20.20	37.37	29.04	7.58	100
Class 2	36	191	272	252	91	842
%	4.28	22.68	32.30	29.93	10.81	100
Class 3	0	31	64	104	50	249
%	0.00	12.45	25.70	41.77	20.08	100
Class 4: Innovators	1	4	6	13	36	60
%	1.67	6.67	10.00	21.67	60.00	100
Total	60	306	490	484	207	1547
%	3.88	19.78	31.67	31.29	13.38	100

Satisfaction with skills increases through the classes

	1	2	3	4	5	Total
Class 1: Laggers	19	54	162	127	34	396
%	4.80	13.64	40.91	32.07	8.59	100
Class 2	18	126	341	280	77	842
%	2.14	14.96	40.50	33.25	9.14	100
Class 3	2	17	77	109	44	249
%	0.80	6.83	30.92	43.78	17.67	100
Class 4: Innovators	0	4	9	19	28	60
%	0.00	6.67	15.00	31.67	46.67	100
Total	39	201	589	535	183	1547
%	2.52	12.99	38.07	34.58	11.83	100

Impact of up-skilling/re-skilling



How frequently does your organisation upskill/reskill employees based on current needs and future advanced technologies requirements via formal programmes?

Up-skilling/re-skilling in the companies

- The crucial role of re-skilling and up-skilling programmes in companies was confirmed
- Thirty-five percent of firms included in Class 4 (Innovators) are upskilling or reskilling their employees on a quarterly basis or more frequently. This could be a consequence of emerging technology usage and a way of continuing the dynamic digital transformation of a company
- The difference in frequency of retraining between firms using technologies intensively and those barely using them is evident

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Full model with robust & clustered std. errors (country)	Restricted - firms with the lowest usage of emerging technologies	Full model, using AI as independent var.	Full model with robust & clustered std. errors (country)	Restricted - firms with the lowest usage of emerging technologies	Full model, using AI as independent var.	Full model with robust & clustered std. errors (country)	Restricted - firms with the lowest usage of emerging technologies	Full model, using AI as independent var.
Variables:	**General IT skills**	**General IT skills**	**General IT skills**	**Profess. IT skills**	**Profess. IT skills**	**Profess. IT skills**	**Data analytics s.**	**Data analytics s.**	**Data analytics s.**
Tech. usage class (Base Class 1 - Laggers)									
Class 2 - Tech. Standard	0.481***			0.070			0.018		
Class 3 - Early Adopters	0.62***			0.352***			0.294***		
Class 4 - Innovators	1.096***			0.922***			0.874***		
Using AI			0.229***			0.245***			0.173***
Size (employees)	-0.0312	-0.0837	-0.00689	0.0614**	0.128	0.0707**	-0.00409	0.0612	0.00808
Upskill frequency	0.267***	0.311***	0.289***	0.312***	0.150**	0.316***	0.0400	0.161**	0.0534
Investing in technology	0.00738	-0.0109	0.0200	-0.124	-0.284	-0.114	0.237***	0.171***	0.243***
No collaboration	0.255***	0.289	0.263***	0.0245	0.0608	0.0346	-0.153	0.0588	-0.144
Multinational company	0.220***	0.606***	0.259***	0.120**	-0.1817	0.135**	0.112	0.277	0.130**
Funding dummy variables:									
Internal funding	0.106	0.160	0.124**	0.0621	0.0696	0.0668	0.149**	0.0891	0.156***
Funding from banks	0.0766	0.212	0.112	0.157***	0.021	0.179**	0.185***	0.0740	0.207***
Government or EC fund.	-0.0735	-0.0101	-0.0557	0.209**	0.160	0.215***	0.133	0.0395	0.140*
Venture capital	0.00604	0.00805	0.0140	0.00735	-0.043	0.0133	0.0563	0.0236	0.0611
Country (Base Poland)									
Denmark	0.0832**	0.375	-0.00479	-0.422***	-0.30	-0.487***	-0.0797**	-0.0456	-0.135
France	0.108***	-0.185	0.0322	-0.437***	-0.341	-0.501***	-0.0990***	-0.0358	-0.149
Germany	0.117***	0.0133	0.0405	-0.417***	-0.3601	-0.475***	-0.117***	0.0934	-0.164
Italy	0.0640	-0.207	-0.0126	-0.434***	-0.310	-0.500***	-0.177***	0.0102	-0.228*
Spain	0.0472	-0.0278	0.00531	-0.318***	-0.326	-0.359***	-0.166***	0.113	-0.195*
Sweden	-0.180***	-0.418	-0.218	-0.307***	-0.129	-0.352***	-0.174***	0.0611	-0.202
Industry (Base IT services)									
Agriculture	-0.237**	0.0505	-0.232*	-0.0847	-0.126	-0.0719	-0.303**	-0.499**	-0.297**
Banking	-0.118	-0.466**	-0.132	0.301***	-0.079	0.290**	0.308***	-0.160	0.297**
Insurance	-0.146	-0.348	-0.193	0.0608	0.305	0.0284	0.246**	0.135	0.216
Healthcare	-0.218*	-0.312	-0.253**	-0.140	-0.175	-0.166	-0.0804	-0.363*	-0.105
Manufacturing - process	0.0116	0.131	0.0420	0.183**	0.228	0.204*	0.0141	-0.0807	0.0343
Manufacturing - discrete	-0.422***	-0.502*	-0.385***	0.0117	0.053	0.0321	-0.0720	0.162	-0.0510
Retail	-0.0556	-0.351	-0.0442	0.199**	0.346	0.216*	0.151	0.260	0.163
Wholesale	-0.147	-0.340	-0.218	0.229*	0.119	0.186	0.0928	-0.0684	0.0509
Media	-0.325***	-0.802	-0.319*	0.00173	0.528	-0.0122	-0.347	-0.311	-0.349**
Logistics	0.217**	-0.0770	0.198*	0.183*	0.348	0.183	0.188***	0.0870	0.183
Utilities	0.00172	-0.0338	-0.0458	0.0736	-0.014	0.0390	0.0460	0.105	0.0163
Government	-0.209	0.352	-0.176	0.190***	0.111	0.226	0.170	0.198	0.193
Education	-0.180*	-0.119	-0.224*	0.0389	-0.005	0.0111	-0.0917	0.00320	-0.118
Observations	1,485	381	1,485	1,485	381	1,485	1,485	381	1,485
Pseudo R^2	0.067	0.05	0.051	0.073	0.04	0.067	0.053	0.042	0.05

Satisfaction with digital skills according to country and industry

	More satisfied	Less satisfied
General IT skills	Germany, France	Sweden
Professional IT skills	Poland	France, Italy
Data Analytics skills	Poland	Sweden, Italy

	More satisfied	Less satisfied
General IT skills	logistics	agriculture, discrete manufacturing, healthcare, and the media
Professional IT skills		banking, manufacturing-process, retail
Data Analytics skills	agriculture	banking, logistics

Conclusion

- We identified four classes of companies in Europe according to their emerging technologies usage: Innovators, Early Adopters, Standard Adopters and Laggers
- The satisfaction with all three skills grows progressively through the classes in relation to the firms with the lowest usage of emerging technologies compared to those using them the most
- Becoming a leader technologically is within the reach of any company with sufficient expertise to advance firm's technological level, and not limited to traditional industrial leaders with larger resources and a competitive advantage on the labour market

Conclusion

- Findings are relevant for the development of the organizational models in technology adoption and, in addition, they can provide interesting input for the design of new models of human capital development, both at the company and the national level.
- Future research could contribute by identifying other relevant factors affecting the firm’s satisfaction in the advanced phases of the digital transformation process.

Thank you.
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