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THE IMPACT OF INNOVATION FRAMEWORK CONDITIONS ON CORPORATE DIGITAL TECHNOLOGY INTEGRATION: INSTITUTIONS AS FACILITATORS FOR SUSTAINABLE DIGITAL TRANSFORMATION

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Abstract. This article is concerned with the impact of corporate digitalization on the corporate sustainability performance and with barriers and supportive institutional frameworks for corporate digital technology adaptation. Collected from *big data* sets such as the *Digital Economy and Society Index (DESI)* country reports and the *Global Innovation Index (GII)*, our study draws on data from 29 European countries. A series of multiple linear regressions was run to select the most relevant predictors of corporate digital technology adaptation. The results suggest that *Rule of Law*, *Government Effectiveness* and *Ease of Starting a Business* are the institutional framework pillars that best predict corporate digital technology adaptation levels. Our findings further show that high levels of corporate digital technology adaptation occur where institutional frameworks are well-integrated across several social domains (economy, politics, legal system, etc.). We conclude by highlighting implications for the design of digital policies aiming at a strategic integration of digital technology adaptation and corporate sustainability.

Keywords: innovation pillars, corporate digital technology integration, sustainability, digitalization, Global Innovation Index, institutions.

JEL Classification: M15, D02, L86, O17, O32.

Introduction

Digital technologies are transforming markets and creating new business opportunities and challenges. Economics and management scholarship needs to match these developments

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with the development of digital theories and methods (Roth, 2019) and systematic explorations of new research fields alike. Against this backdrop, Beier et al. (2017) and Gregori and Holzmann (2020) argue that one particularly relevant research frontier pertains to the potential impacts of corporate digitalization on the corporate sustainability performance. The key idea here is that digital technology integration may contribute to social, environmental, and financial value creation for corporate stakeholder. In this sense, the systematic digital transformation of a considerable number of businesses and industries might add up to a consistent contribution to the United Nations sustainable development goals (SDGs) (Hinson et al., 2019).

Yet, for other reasons, too, corporate digitalization has become an imperative under the motto "digitalize or drown" (Schreckling & Steiger, 2017).

During the Covid-19 pandemic, there has been unprecedented pressure for companies to pursue digital innovation or integration of digital technologies (Huang et al., 2021). Digital innovation is now important not only for technology-driven companies and IT departments but critical to almost every industry and functional unit (Ruiz-Real et al., 2021).

Understanding what supports digitalization and "digital transformation" from the national innovation systems factors is, therefore, essential for the individual survival and sustainable development of firms (Agarwal et al., 2010). There is hence considerable momentum for research on the barriers to corporate digital technology integration and complementary roles of governments in supporting or impeding such digital transformations, though Chen et al. (2021) underline the need for more quantitative research capable of determining which barriers and governance structures are the most supportive of the digital transformation in small businesses. Moreover, there is the explicit need for studies focusing on potential impacts of corporate digital transformations on the sustainability performance of larger social systems (Cricelli & Strazzullo, 2021).

The present article addresses these gaps by studying the impact of innovation framework conditions on facilitating the digital transformation of companies. The aims of our study are, therefore, twofold: firstly, to assess potential causal relationship between the country-level Global Innovation Index (GII) innovation pillars and sub-pillars and the levels of corporate digital technology integration, and secondly, to explore the role national innovation framework conditions might play in shaping a sustainable digitalization of businesses. For this purpose, we have developed multi-method research design.

Our study first presents the theoretical framework that includes a systematic review of literature on the topic of corporate digital technology integration and the factors influencing it. Based on this review, we provide an overview of critical pillars of institutional frameworks for sustainable corporate digital technology adaptation and infer our research questions. We then draw on scatterplots to visualise the relationships between the innovation framework conditions and corporate digital transformation; on correlation analyses to identify the innovation frameworks that most correlate with corporate digital technology adaptation; and on regression analyses to assess the influence of specific innovation framework pillars and sub-pillars on corporate digital technology adaptation. After the presentation and discussion of the main results, we draw conclusions for the design of digital policies aiming at a strategic integration of digital technology and corporate sustainability.

1. Theoretical framework and research question

As Osmundsen et al. (2018) found in the literature, researchers typically characterize digital transformation as "a major organizational change driven by, built on, or enabled by digital technology, altering how business is conducted". In a similar vein, Liu et al. (2011) refer to corporate digital technology integration as "the integration of digital technologies into business processes".

Business organizations choose to integrate digital transformation into their activities, being influenced by different external and internal drivers. Among the most important ones, researchers mention: a need to adapt to changing customer behaviours and expectations, a need to keep up with digital shifts occurring in the industry in which they operate (Osmundsen et al., 2018), and changes and challenges in the competitive landscape, such as an expanding range of rivals and non-industry entrants, competitors' demonstration of digital advances, new market entrants with disruptive digital business models, and technological progress, in general (Osmundsen et al., 2018).

1.1. Factors influencing corporate digital technology integration

It is widely acknowledged that the innovation ecosystem is a key *macro-level* cornerstone of a digital economy acting as a framework for the organizational strategy-making (Autio & Thomas, 2014).

Across the European Union (EU), the size of companies, broadband connections, social media, and mobile applications are also factors that conduct to digital transformation in companies, with the remark that the size of companies is a significant enabling factor (European Commission, 2018b). In the EU countries, there are five pillars / enabling factors that conduct countries to achieve digital transformations: digital infrastructure, e-leadership, entrepreneurial culture, investments and access to finance, supply, and demand of digital skills (European Commission, 2018a). Big Data and the Internet of Things (IoT) bring improvement processes and digitalization into companies, being thus considered key digitalization enablers (Sestino et al., 2020). Telecommunication networks and data centres are the two main pillars when it comes to the implementation of a digitalization strategy (Osburg & Lohrmann, 2017).

On a microlevel, digital competencies and the actions of the board of directors are important for implementing the digitalization in businesses (Golubev et al., 2020). Investment in human capital is a key factor for achieving new technological changes (Herman & Suciu, 2019). Additionally, the organizational strategy, as well as the financial and technological aspects (such as Information Technology) are the factors that influence the digitalization achievements (Ekman et al., 2020).

Even though these and further factors can be analysed at macro and micro levels, we may conclude that the macroeconomic framework is a critical facilitator of the integration of digitalization in companies and the organizational factors appearing with the integration of digitalization in firms ultimately lead to macroeconomic (national) digitalization actions.

1.2. Innovation pillars as factors of influence for sustainable integration of digital technology by companies

The concept of "digital sustainability" is a materialization of the accessibility, maintenance, promotion and technological aspect of digital content in companies (Wut et al., 2021). Often interrelated in the perspective of digital transformation, company innovativeness and technology adoption (Blichfeldt & Faullant, 2021) have to be targeted also for sustainability. The sustainable way of doing business can bring up digitalization and vice versa, and the vision of the market is pushing business to be sustainable. There are two options for achieving the sustainability of digitalization: "Green by IT" and "Greening IT". The first approach involves more sustainable and efficient processes through the IT systems, while the second approach is about making the IT more sustainable (Osburg & Lohrmann, 2017).

In a time of sustainable development goals (SDGs) and global transitioning to new technologies, strategic research agenda should target complete and robust exploration of the unknown, and the process must foster a variety of potential paths to spur innovation To foster digital innovation, new governance principles could help in the endeavour to protect and support the capacities of businesses in shaping the unknown: in France, the legal status of "profit-with-purpose company" reinforces and protects the capacity of the company to explore certain unknowns (Cornell University et al., 2020).

Digital transformations bring new tools and there is evidence that innovation and business sophistication, contribute greatly to explaining the competitive advantage of economies (Farinha et al., 2018), supported by institutions, such as regulation or rule of law, which are critical for sustainable digital integration (Didenko, 2018). With the help of technology integration that is being reset into new shapes with digital tools, innovation pillars may contribute to sustainable industries. There have appeared key considerations and new global trends (Hinson et al., 2019).

In the context of digital and socio-economic transformation (Roth, 2021), common efforts of governmental structures, social institutions and business community are needed in addressing the challenges of sustainable development of the national economy (Salimova et al., 2020). Regional institutions, such as the quality of public services (government effectiveness) and the degree of association and social cooperation have contributed to the creation of a fertile ecosystem able to promote innovative capacities (Mosconi & D'Ingiullo, 2021). In high tech industries, local institutional quality (especially the rule of law and the regulatory quality) showed an impact on setting-up new businesses in Italian provinces during 2004–2012. The results show that local institutional quality positively affects entry rates, and its impact is stronger in high-tech industries (Agostino et al., 2020).

In the light of the above, we consider that innovation pillars are factors of influence for the sustainable integration of digital technology by companies. To reflect the innovation pillars, Global Innovation Index (GII) was launched in 2007 by Cornell University, INSEAD and the World Intellectual Property Organization [WIPO], which is used in several areas, all connected to innovation activities (Kawabata & Camargo Junior, 2020). GII was built to promote national innovation strategies and the international discussion on innovation and design policies. It was designed to compare the relative performance of the innovation system

among countries by analysing their strengths and weaknesses, and was aimed to stimulate the uptake of innovation indicators in the surveyed countries (Cornell University et al., 2018). GII comprises seven pillars and each pillar is divided into sub-pillars, each sub-pillar being the product of relevant individual indicators.

GII is calculated as an arithmetic mean of the scores of the two sub-indexes (*the Innovation Input Index and the Innovation Output Index)*, five and two pillars, respectively. Each of these pillars describe a feature of innovation and comprise it, and include up to five indexes, their score being calculated using the weighted average method (Cornell University et al., 2020).

The Institutions are the first innovation pillar of GII (Bag et al., 2021; Hetemi et al., 2020; Hinings et al., 2018; Kawabata & Camargo Junior, 2020; Farinha et al., 2018). This pillar captures the institutional framework of an economy with 3 sub-pillars: political, regulatory, and business environment. The second innovation pillar is ***human capital and research*** (Herman & Suciu, 2019), with the following sub-pillars: education, tertiary education, research & development (R&D). The third pillar is ***infrastructure,*** and its sub-pillars are: ICTs, General infrastructure, and Ecological sustainability. The fourth pillar is ***market sophistication*** with the sub-pillars: credit investment trade, competition, & market scale, while the fifth pillar is ***business sophistication*** (with sub-pillars: knowledge workers, innovation linkages, knowledge absorption). The next 2 pillars are ***knowledge and technology outputs*** (the sixth) with the sub-pillars: knowledge creation, knowledge impact, and knowledge diffusion, and the seventh is ***creative outputs***, with sub-pillars: intangible assets, creative goods, and creativity of online services.

In this study, we analyse the influence of innovation pillars on digital technology integration by businesses. For this purpose, we identify the specific innovation framework conditions that are the best predictors for digital technology integration, and we calculate the direction and intensity of the identified relationships.

In the light of the above and in line with our two-fold aim, the key research questions of this paper are:

- RQ1. Which are the pillars and the sub-pillars of innovation that best predict the integration of digital transformation by businesses?
- RQ2. How could the innovation framework conditions have a role in the sustainable digitalization of companies?
- RQ3. Is the institutional context (e.g., through regulations) the main factor leading to a "sustainable" integration of digital technology by businesses?

2. Data sources and methods

2.1. Data sources

Data used in the study have been extracted from the DESI country reports (Digital Economy and Society Index (European Commission, 2020), the DESI 2020 reports based on 2019 data and from the GII database (Global Innovation Index) (Cornell University et al., 2020; WIPO, 2021), where the year of reference was also 2019. The study included in its analysis European 29 countries (EU28, including Great Britain and Norway).

The Digital Economy and Society Index (DESI) is a composite index that summarises relevant indicators of Europe's digital performance, it tracks the progress of EU Member States in terms of their digital competitiveness. We measured digital technology integration by businesses using an indicator called similarly, which is the fourth dimension of the DESI index. For convenience, this variable in this study is codified as DESI4. The values of DESI4 are expressed as a percentage (%).

To describe the innovation framework conditions, we used the pillars and the sub-pillars of the GII index (presented in section *2.3 B*). The 7 pillars were assigned scores from 0 to 100 (0 = lowest performance; 100 = highest performance). In our analysis, for the sub-pillar dimensions we have not used their scores but their values.

2.2. Data analysis

We adopted a research methodology which uses quantitative measures to get an in-depth understanding of the influence of the innovation pillars on the digital transformation of businesses.

Scatterplots: The relationships between the innovation framework conditions and the digital transformation of businesses were studied by examining the scatterplots diagrams corresponding to the distributions of countries by scores assigned to each innovation pillar and sub-pillar and by the relative level of digital technology integration by companies.

Correlation analysis: Resulting relationships were further assessed using *correlation analysis* as to identify the innovation framework conditions that most correlate with digital technology integration in firms, which could be useful for ensuring the sustainability of this process.

Regression analysis: We used regression analysis to assess the influence of innovation pillars and sub-pillars on digital technology integration in businesses.

To identify the innovation pillars and sub-pillars that best predict the digitalization of businesses, we divided our analysis into two phases, as follows.

In estimating the model, we first chose *Digital technology integration by businesses* as the dependent variable, while the independent variables were the seven pillars of innovation activities that comprise the Global Innovation Index (GII) (*Institutions*; *Human Capital and Research, Infrastructure, Market Sophistication, Business Sophistication*, *Knowledge and Technology Results, Creative Results).* In phase two, we kept in the model only the sub-pillars of the innovation pillars found in phase one to best predict the *Digital technology integration by businesses*. Multiple linear regression was used to estimate the model and the *Stepwise* procedure, available in SPSS, as to select the most relevant variables to be included in the model.

3. Results

3.1. Data analysis

The visual appearance of scatterplot diagrams (Figure 1 and Appendix – Figure A1) displaying the distributions of countries by scores for each innovation pillar and by the relative level of digital technology integration by companies justify the use of linear regression to study the relationship between DESI4 and the innovation pillars.

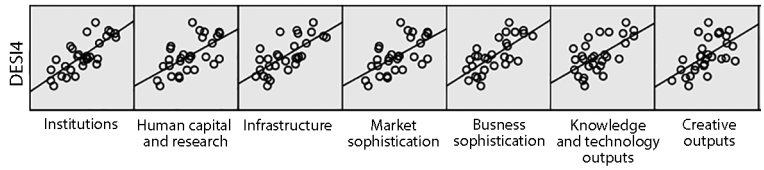

Figure 1. The relationship between DESI4 and the 7 pillars of GII

To identify best predictors of DESI4, we first introduced to the model the 7 factors describing the innovation activities, and then applied the *Stepwise* method to this initial set of factors. The used algorithm identified *the Institutions* as the significant predictor factor for digital technology integration by businesses. The resulted regression model summary (Table 1, model 1) shows that it explains 57.7% (adjusted $R^2 = 0.577$) of variation in the level of digital technology integration.

For the remaining set of 6 factors, the *Stepwise* method was applied again, and the algorithm identified a new factor as a significant predictor of digital technology integration, namely, *Business Sophistication.* The resulted regression model summary (Table 1, model 2) shows that it explains 48.5% (adjusted $R^2 = 0.485$) of the variation in the level of digital technology integration. To show both the influence of institutions and of business sophistication on digital technology integration by businesses, we also simulated the third model which included both factors. The estimated model explains 58.4% (adjusted $R^2 = 0.584$) (Table 1, model 3) of the variation of dependent variable. The ANOVA results for the estimated regression models show a value of F statistic equal to 39.128 (Sig. = 0) for Model 1, of 27.334 (Sig. = 0) for Model 2 and of 20.644 (Sig. = 0) for Model 3, which indicates that the two innovation pillars explain, both alone and together, to a high degree the variation in the level of integration of digital technology by enterprises.

Both *Institutions* and *Business Sophistication* have a positive influence on digital technology integration by companies.

Selection of the optimal model requires a choice of the model with the highest value of the R^2 determination coefficient and the lowest number of variables. Of the three analysed models used in our study to predict the variation in the digital technology integration by businesses, the first and the third explain more than 50% of this variation, which qualifies them as adequate models. Considering that the inclusion into the model 3 of the variable *Business Sophistication* adds only 0.7% to the explained variation, we believe that the fist model is optimal, the model by which we predict the level of digital technology integration in companies by characteristics of the institutional framework in an economy.

The value of 0.769 of the correlation coefficient *R* (Table 1, model 1) indicates a quite strong relationship between the observed values describing the institutional framework of an economy and the values predicted for the level of digital technology integration by businesses. Plus, the positive value of estimated Beta coefficient for the variable *Institutions* (Table 2, model 1) shows that the more organised is the institutional framework in an economy (political environment, regulation environment, business environment), the higher is the degree shown by companies of their digital technology integration.

Table 1. Model summary (pillars)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.769(a)	0.592	0.577	9.0592
2	0.709(b)	0.503	0.485	9.9942
3	0.783(c)	0.614	0.584	8.9808

Note: a. Predictors: (constant), Institutions; b. Predictors: (constant), Business Sophistication; c. Predictors: (constant), Business Sophistication, Institutions; d. Dependent variable: DESI4.

The correlation analysis (Appendix – Table A1) has found direct moderate and statistically significant relationships between DESI4 and all innovation pillars. The strongest relationships are with the *Institutions* and *Business Sophistication* pillars. Also, it shows moderate to strongly direct and statistically significant relationships between the *Institutions* and the other innovation pillars, the strongest being with *Business Sophistication*, *Human Capital and Research* and *Market Sophistication*. This could explain why the *Institutions* are the best predictor out of all innovation pillars for the DESI4 as it explains a big part of the variation of the other pillars, being at the same time the indicator with the strongest relationship with the DESI4.

Table 2. Regression coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	–67.495	17.549		–3.846	0.001
	Institutions	1.361	0.218	0.769	6.255	0.000
2	(Constant)	–3.437	8.844		–0.389	0.701
	Business sophistication	0.951	0.182	0.709	5.228	0.000
3	(Constant)	–54.613	20.378		–2.680	0.013
	Institutions	1.001	0.367	0.566	2.727	0.011
	Business sophistication	0.338	0.278	0.252	1.214	0.236

Note: a. Dependent Variable: DESI4.

3.2. Relationship between DESI4 and the 7 sub-pillars of institutions

As *Institutions* are the most important innovation pillar to be discussed in relation with digital transformation of firms, we will be exploring this relationship more deeply by investigating the relationships between the components of the *Institutions* pillar and digital technology integration by businesses.

The Institutions pillar has three dimensions – Political environment, Regulatory environment, and Business environment. The visual display of scatterplot diagrams for distributions of countries (Figure 2 and Appendix – Figure A2) by the scores corresponding to each of the seven sub-pillars of the Institutions pillar and the relative level of digital technology integration by companies could justify the use of linear regression for studying the relationship

between the DESI4 and the sub-pillars, except the sub-pillar Cost of Redundancy Dismissal, for which, no relationship with the DESI4 was found.

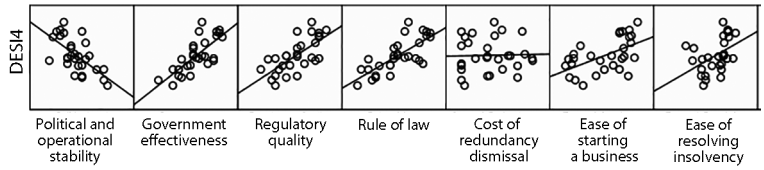

Figure 2. The relationship between the DESI4 and the 7 sub-pillars of the *Institutions* pillar

The correlation analysis (Appendix – Table A2) has identified moderate direct and statistically significant relationships between the DESI4 and the sub-pillars *Government Effectiveness*, *Regulatory Quality*, *Rule of Law*, *Ease of Starting a Business* and *Ease of Resolving Insolvency*.

We observe a moderate inverse and statistically significant relationship between the DESI4 and *Political and Operational Stability* (Pearson correlation = –0.640, sig. = 0). No relationship was identified between the DESI4 and *Cost of Redundancy Dismissal*. The strongest relationships of the DESI4 are with the sub-pillars *Rule of Law*, *Government Effectiveness* and *Regulatory Quality* (Pearson correlation > 0.7, sig. = 0). Also, there are moderate to strong and statistically significant relationships between *Rule of Law* and the other sub-pillars, except for *Cost of Redundancy Dismissal*, the strongest being with *Government Effectiveness* and *Regulatory Quality* (Pearson correlation > 0.9, sig. = 0). The relationship between *Rule of Law* and *Political and Operational Stability* is inverse, and positive between *Rule of Law* and the other sub-pillars.

These identified relationships could explain why the *Rule of Law* is the best predictor out of all sub-pillars of *Institutions* for DESI4 because it also explains a big part of the variation of other sub-pillars, being at the same time the indicator with the strongest relationship with the DESI4.

Table 3. Model summary (sub-pillars): regression model between DESI4 and the sub-pillars of *Institutions* – Stepwise algorithm

Model	Predictors	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	(Constant), Ease of Resolving Insolvency, Cost of Redundancy Dismissal, Political and Operational Stability, Ease of Starting a Business, Regulatory Quality, Government Effectiveness, Rule of Law	0.805	0.648	0.531	9.5378
2	(Constant), Rule of Law	0.756	0.571	0.555	9.2881
3	(Constant), Government Effectiveness	0.752	0.565	0.549	9.3476
4	(Constant), Regulatory Quality	0.701	0.492	0.473	10.1072
5	(Constant), Regulatory Quality, Ease of Starting a Business	0.757	0.573	0.540	9.4412
6	(Constant), Ease of Starting a Business, Rule of Law	0.794	0.630	0.602	8.7845

Table 4. Regression coefficients (a)

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error			
1	(Constant)	–53.450	42.916		–1.245	0.227
	Political and Operational Stability	–3.368	10.225	–0.099	–0.329	0.745
	Government Effectiveness	2.411	12.499	0.096	0.193	0.849
	Regulatory Quality	0.831	9.397	0.030	0.088	0.930
	Rule of Law	8.662	12.370	0.375	0.700	0.491
	Cost of Redundancy Dismissal	0.173	0.448	0.057	0.387	0.703
	Ease of Starting a Business	0.856	0.454	0.288	1.886	0.073
	Ease of Resolving Insolvency	0.101	0.173	0.105	0.584	0.565
2	(Constant)	22.137	3.703		5.978	0.000
	Rule of Law	17.467	2.915	0.756	5.992	0.000
3	(Constant)	20.697	3.958		5.229	0.000
	Government Effectiveness	18.864	3.184	0.752	5.925	0.000
4	(Constant)	18.790	4.872		3.857	0.001
	Regulatory Quality	19.488	3.813	0.701	5.111	0.000
5	(Constant)	–60.568	35.982		–1.683	0.104
	Regulatory Quality	15.823	3.924	0.569	4.032	0.000
	Ease of starting a Business	0.933	0.420	0.314	2.223	0.035
6	(Constant)	–47.231	34.091		–1.385	0.178
	Rule of Law	14.684	3.074	0.635	4.776	0.000
	Ease of Starting a Business	0.809	0.395	0.272	2.046	0.051

Note: a. Dependent Variable: DESI4.

In Table 4 we identified the best predictors of the DESI4 out of the sub-pillars of *Institutions*. We first introduce to the model all 7 sub-pillars and apply the *Stepwise* method to this set of factors.

The used algorithm has identified the *Rule of Law* as a significant predictor of digital technology integration in business. The resulted regression model summary (Table 3, model 2) shows that it explains 55.5% (Adjusted $R^2 = 0.555$) in the variation of the level of digital technology integration.

For the remaining set of 6 factors, the *Stepwise* method was again applied, and the algorithm identified a new sub-pillar as a significant predictor of digital technology integration

by companies, namely, *Government Effectiveness*, which explains 54.9% (Adjusted $R^2 = 0.549$, Table 3, model 3) in the variation of the level of digital technology integration.

If we eliminate from the list of factors both the *Rule of Law* and *Government Effectiveness*, then the new model that explains best the DESI variation from one country to another is the model having as predictors *Regulatory Quality* and *Ease of Starting a Business* (Adjusted $R^2 = 0.540$, Table 3, model 5).

As correlation coefficients between the *Rule of Law* and *Government Effectiveness*, and, between *Rule of Law* and *Regulatory Quality,* respectively, are extremely high (over 0.9), we could use only the *Rule of Law* as a DESI4 predictor because it reflects to a great extent also the changes in the other two pillars.

Another variable that could be included into the model is *Ease of Starting a Business* as its DESI4 correlation coefficient is > 0.5, and its coefficient correlation with the *Rule of Law* is not that high so that the modification of the *Rule of Law* sub-pillar would reflect sufficiently the changes in the *Ease of Starting a Business* sub-pillar.

To describe both the influence of the *Rule of Law*, and of the *Ease of Starting a Business* on digital technology integration in business, we simulated also the sixth model, in which we included both factors. The estimated model explains 60.2% (Adjusted $R^2 = 0.602$, Table 3, model 6) of the dependent variable variation.

The ANOVA results for the estimated regression models show values of the F statistic significance (Sig. = 0.001 for Model 1, Sig. = 0 for the other five models, Table 5) which indicate that the selected combinations of sub-pillars explain to a high degree the variation in the level of digital technology integration by enterprises.

Table 5. ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3516.770	7	502.396	5.523	0.001(a)
	Residuals	1910.348	21	90.969		
	Total	5427.118	28			
2	Regression	3097.849	1	3097.849	35.909	0.000(b)
	Residuals	2329.269	27	86.269		
	Total	5427.118	28			
3	Regression	3067.926	1	3067.926	35.111	0.000(c)
	Residuals	2359.192	27	87.377		
	Total	5427.118	28			
4	Regression	2668.946	1	2668.946	26.127	0.000(d)
	Residuals	2758.172	27	102.155		
	Total	5427.118	28			
5	Regression	3109.583	2	1554.791	17.443	0.000(e)
	Residuals	2317.535	26	89.136		
	Total	5427.118	28			

End of Table 5

Model		Sum of Squares	df	Mean Square	F	Sig.
6	Regression	3420.745	2	1710.373	22.164	0.000(f)
	Residuals	2006.373	26	77.168		
	Total	5427.118	28			

Note: a. Predictors: (constant), Ease of Resolving Insolvency, Cost of Redundancy Dismissal, Political and Operational Stability, Ease of Starting a Business, Regulatory Quality, Government Effectiveness, Rule of Law; b. Predictors: (constant), Rule of Law; c. Predictors: (constant), Government Effectiveness; d. Predictors: (constant), Regulatory Quality; e. Predictors: (constant), Regulatory Quality, Ease of Starting a Business; f. Predictors: (constant), Ease of Starting a Business, Rule of Law; g. Dependent Variable: DESI4.

4. Discussion

This study analyses the influence of innovation pillars on digital technology integration by businesses by identifying the innovation framework conditions that are best predictors of digital technology integration and by measuring the direction and intensity of the identified relationships. To answer our two-fold objective, we will be answering the key research questions considering our results:

RQ1. Which are the pillars and the sub-pillars of innovation that best predict integration of digital transformation by businesses?

Our empirical analysis first investigated the relationship between DESI4 and the pillars of GII (Institutions; Human capital and research; Infrastructure; Market sophistication; Business sophistication; Knowledge and technological results; Creative results).

The results indicate that out of the seven pillars, *Institutions* is the best innovation pillar predictor for DESI4, *i.e.,* it explains the significant part of its variation from one country to another.

To perform a deeper analysis, we also analysed the relation between DESI4 and the sub-pillars of *Institutions*. It showed that out of *Institution* sub-pillars, the best predictors of DESI4 are *the Rule of Law*, *the Government Effectiveness,* and the *Regulatory Quality.* The sub-pillar the *Rule of Law* explains 55.5% of the DESI4 variation, being also correlated with 5 out of other 6 sub-pillars (most strongly with the Government Effectiveness and the Regulatory Quality. If we remove the *Rule of Law* from the list, the *Government Effectiveness* becomes the best predictor, and if we remove it also, then the model that best describes the DESI4 variation from one country to another has the *Regulatory Quality* and the *Ease of Starting a Business* as predictors. The relationship between *Ease of Resolving Insolvency* and DESI4 (Pearson correlation < 0.5) and its inclusion into the model would not contribute significantly to explaining the level of DESI4. The relationship between DESI4 and *Cost of Redundancy Dismissal* was not found. So, it results that this pillar is not a good predictor of DESI as it does not explain the DESI4 variation from one country to another.

Except the *Cost of Redundancy Dismissal*, we may observe moderate and statistically significant relationships between DESI4 and the sub-pillars. The relationship between DESI4

and the *Political and Operational Stability* is moderate and inverse, meaning that companies are more likely to integrate digital technology into their activity as the political, legal, operational and security risks are lower. Other relationships between DESI4 and the sub-pillars of *Institutions* are direct. Because correlation coefficients between the *Rule of Law* and the *Government Effectiveness* and between the *Rule of Law*, *Regulatory Quality* and the *Political and Operational Stability*, respectively, are high and very high, we can use only the *Rule of Law* as the predictor of DESI4 as it also reflects the changes in the other two pillars.

The *Ease of Starting a Business* is also significant to the model with its coefficient correlation with DESI4 is greater than 0.5, and with the *Rule of Law* is not that high so that changes occurring in the *Rule of Law* significantly affected the changes in the *Ease of Starting a Business* sub-pillar.

Considering the models analysed in the section 4.2 and what has been mentioned above, we may note that the models that best explain the variation in the level of digital technology integration by businesses from one country to another are, in order, 6, 2, 3 and 5 (see Table 3), the model that explains most of the variation of DESI4 from one country to another being the one that considers the following sub-pillars as predictors: *Rule of Law* and *Ease of Starting a Business*. It follows that our discussion should focus on the relationship between the *Institutions* and the digital technology integration by businesses (*RQ3*), as well as on the relationship between the 3 sub-pillars of the *Institutions Pillar – Rule of Law*, *Government Effectiveness* and *Ease of Starting a Business* – and the digital technology integration by businesses (*RQ2*).

RQ2. How could the innovation framework conditions have a role in the sustainable digitalization of businesses?

1. Rule of Law and digital technology integration into business

Our results indicate that companies are more likely to integrate digital technology into their activity if they have more confidence in and abide by the rules of society, and trust the quality of contract enforcement, property rights, the police, and the courts, and the likelihood of crime and violence being lower.

Botero et al. (2012) claim that by intensifying the rule of law, states achieve more a cultural benefit than a technical one, while Bayamlıoğlu and Leenes (2018) agree that techno-regulation influences individual behaviours and creates legal effects. In the developing world, the rule of law is an extremely important input for planning, operations, and administration (Botero et al., 2012). Technological innovation facilitates equal access to justice, offers more transparency and eliminates discrimination (United Nations Office on Drugs and Crime, 2020).

Against this backdrop, our results indicate that companies are more inclined to integrate digital technology in their business as they have more confidence in and abide by the rules of society. As we have observed in the literature, rule of law plays an important role in development and in new technology integration, which influences digital transformation of companies and may also promote the triple bottom line perspective. Also, digitalization influences the rule of law' extension. If there is a digitized law, then companies will need to adapt and keep up with this level of innovations. Technology and the digitalization of the economy

and governments generate massive data that could be used to stimulate the innovation and development of well-informed and better targeted policies and services.

2. Government effectiveness – and digital technology integration into business

Our findings show that businesses are more likely to integrate digital technology into their activity as there are perceptions of high quality of public services, of the civil service's independence from political pressures, and of the quality of policy formulation and implementation, as well as of the credibility of the government's commitment to such policies. These findings have implications for the design of digital policies aiming to support companies to integrate digital technologies and digital sustainability and manage various actors and actions to be implemented.

Our findings show that a high government effectiveness stimulates digital technology integration in business. The studies show that government digitalisation intensifies government effectiveness. Therefore, governments should increase their own effectiveness to stimulate digital technology integration by businesses, a goal that could be reached by adopting digital transformation of public institutions.

Examples of good practices presented by the literature in the field teach us that to increase efficacy and to contribute to sustainable digital technology integration by businesses, governments should develop digitalisation strategies aiming to develop a safe and secure digital environment, a collaboration with stakeholders supporting policies promoting digitalisation, and partnerships with the business community to facilitate data sharing and technological advancement, maintaining transparent, flexible and adaptable governance.

3. Ease of Starting a Business and the integration of digital technology into business

Our study provides evidence that companies are more likely to integrate digital technology into their activity, into all the officially required procedures, or into the commonly done in practice procedures if for an entrepreneur it is easier to open a start-up, formally an industrial or commercial business, and if the time and cost to complete such procedures is lower, as well as the minimum paid-in capital. These procedures include obtaining all necessary licenses and permits and completing any required notifications, verifications, or inscriptions for the company and employees with relevant authorities. *The Ease of starting a business* is the third *Institutions* sub-pillar that positively correlates with the degree of digital technology integration into business.

Our findings are in line with those of a benchmark analysis carried out by (Deloitte, 2013), who assessed digital and entrepreneurial policies and schemes across five countries, regions or cities so as to identify what actions can be taken both by public and private sector in order to enhance digital entrepreneurship. Our results have also been confirmed also by the report made by the study of Chakravorti et al. (2019), who found a modest correlation of 0.42 (coefficient) between the *Doing Business* and the EDDB scores, yet also that the distribution of their scores showed higher scores for the EDDB index in economies with high scores of the *World Bank Doing Business index*. In our study, the correlation coefficient between the *Ease of starting a business* and the *Integration of Digital Technology by Businesses* is not as high as for the two previously analysed sub-pillars (coefficient of 0.553), the relationship being significant and important that is worth being further researched.

As shown by the Chakravorti et al. (2019) study, these mixed findings could be explained by the specific features of businesses that include a high degree of digital technology. The Dobrolyubova et al. (2019) study showed a direct cause and effect link between e-government development index and *Doing Business* measures. This means that the digitalisation of public administration may contribute to ease of starting a business, stimulating the integration of digital technology by businesses.

Our findings thus indicate that a high score for *Ease of starting a business* could stimulate the integration of digital technology in business, although the correlation is moderate. Studies show that this result could be due to specific features of digital entrepreneurship bringing additional challenges to those encountered in traditional business when starting and developing a business. It tells us that to grow *ease of starting a business* and contribute to sustainable integration of digital technology by businesses, governments and policymakers should stimulate more digital business. Consequently, digital business environments require a distinctive policy focus and investments compared to traditional businesses. Governments and policymakers should facilitate greater access and should eliminate barriers to digital platforms as these facilitate access to global market and are the core of digital business.

RQ3. Is the institutional context (e.g., through regulations) the main factor leading to "sustainable" integration of digital technology by businesses?

Our findings show that a high level of integration of digital technology by businesses occurs when the institutional framework of an economy (political, regulatory, and business environment) is better organised, and regulations can support technology integration and contribute to innovation. The 2030 Agenda calls for special attention to be paid to effective, responsible, and inclusive institutions in order to promote sustainable societies (Othman et al., 2020). According to a recent systematic review (Cricelli & Strazzullo, 2021) on the economic aspect of digital sustainability, the integration of digital technologies enables companies to foster innovation, lowers the energy waste, recovers resources, expands the market share, facilitates the carrying out of organisational activities, and also increases productivity and reduces costs.

Against this backdrop, our results emphasize the importance of supporting institutions for innovation and technology integration in business.

Conclusions

Digital technology integration in companies leads to transformation in terms of competitive advantage, cost reduction, improved services, and products, also contributing to the minimization of likely negative economic, ecological, and social effects. Every new innovation and the changes it brings about may have significant consequences for the precarious relationship between organisational complexity and sustainability.

Our research aimed to assess the causal relationship between critical pillars of national innovation frameworks and corporate digital technology integration as well as to explore the role these framework conditions play in shaping a sustainable digitalization of businesses.

We found *Institutions* to be the innovation pillar that best predicts the level of corporate digital technology integration. Our findings show that a high level of corporate digital tech-

nology integration occurs when the institutional framework of an economy (political, regulatory, and business environment) is better organised, and regulations can support technology integration and contribute to innovation.

Out of *Institutions sub-pillars*, *the Rule of Law*, *Government Effectiveness* and *Ease of Starting a Business* are the most important for being discussed in relation to digital transformation of businesses. Our study provides evidence that companies are more likely to integrate digital technology into their activity as agents have more confidence in and abide by the rules of society, there are higher perceptions of the quality of public services, of the civil service's independence from political pressures, and of the quality of policy formulation and implementation, and there are easier procedures and lower time and costs to start a business.

These results show that institutional context is the main factor leading to the integration of "sustainable" technological innovations. Regulation does not pay the main role, but the rule of law contributes to the achievement of sustainable development goals and provision of proper environment for sustainability.

Our results are in line with the EU 2030 Agenda calling for special attention to be paid to effective, responsible, and inclusive institutions for promoting sustainable societies, and with the findings of other studies emphasizing that institutions may contribute in multiple ways to sustainable integration of digital technology by businesses through the creation of a predictable and supporting business environment facilitating technology convergence, while also complying with sustainable development goals.

Our research summarises and underlines both the specific requirements and examples of good practices that should be considered and applied to strengthen the three innovation sub-pillars (*Rule of Law*, *Government Effectiveness* and *Ease of Starting a Business*) to encourage and support sustainable corporate digital technology integration.

This study extends prior knowledge on sustainable digital transformation of business by bringing evidence and bringing arguments on multiple roles that institutions could play in the entrepreneurial ecosystem of this process. Therefore, institutions are an essential factor in sustainable integration of digital technology by businesses:

Our results reinforce the crucial role of the institutional context, and especially the role of rule of law, government effectiveness and ease of starting a business, for sustainable corporate digital technology integration.

Our research findings have implications for the design of digital policies aiming to support companies fostering the integration of digital technologies and digital sustainability, managing various actors, and implementing actions.

To foster digital technology integration and innovation, this study could further the understanding of sustainability and the importance of rule of law. For sustainable reasons, stakeholders may rethink the meaning and value of digitalization before they embrace emerging digital technology, rather than pursue innovative technology for short-lived benefits.

Limitations

The study used secondary data provided by GII and DESI referring only to the EU and the UK. Moreover, the use of this aggregate data does not allow us to describe the specificity of

the digital technology integration process by country as to reflect cultural, social, and economic specificity of each country.

Another limitation of this study is that digitalization of businesses is influenced by several factors. In the literature review, we managed to group them into microeconomic factors and macroeconomic factors. In our study, however, we focused exclusively on the macroeconomic perspective.

Future lines of research

Future research might therefore analyse the factors facilitating digital technology integration with an organization- or country-level focus. In this context, even more fine-grained analyses of specific organization or industry types might prove to be insightful.

Poorly developed institutional settings force entrepreneurs to look for solutions to fill the corresponding institutional gaps (lack of political stability, numerous legislative changes, undermined rule of law, weak business support of institutions and bureaucracy for starting a business). We consider further exploration of these aspects as well as their interplay to be a promising field of future research.

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APPENDIX

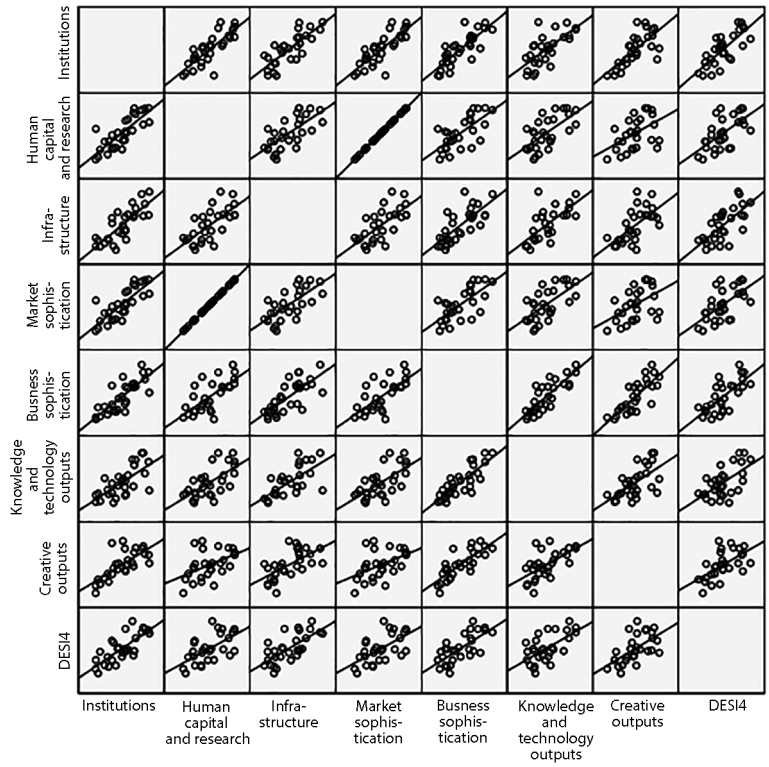

Figure A1. The bivariate links between DESI4 and each pillar of GII and the bivariate links between the GII pillars

Table A1. Correlations between DESI4 and each pillar of GII and between GII pillars

		DESI4	Institutions	Human Capital and Research	Infrastructure	Market Sophistication	Business Sophistication	Knowledge and Technology Outputs	Creative Outputs
DESI4	Pearson Correlation Sig. (2-tailed) N	1 29	.769** .000 29	.620** .000 29	.697** .000 29	.620** .000 29	.709** .000 29	.611** .000 29	.590** .001 29
Institutions	Pearson Correlation Sig. (2-tailed) N	.769** .000 29	1 29	.805** .000 29	.798** .000 29	.805** .000 29	.809** .000 29	.691** .000 29	.714** .000 29
Human Capital and Research	Pearson Correlation Sig. (2-tailed) N	.620** .000 29	.805** .000 29	1 29	.695** .000 29	1.000** .000 29	.700** .000 29	.648** .000 29	.482** .008 29
Infrastructure	Pearson Correlation Sig. (2-tailed) N	.697** .000 29	.798** .000 29	.695** .000 29	1 29	.695** .000 29	.741** .000 29	.681** .000 29	.628** .000 29
Market Sophistication	Pearson Correlation Sig. (2-tailed) N	.620** .000 29	.805** .000 29	1.000** .000 29	.695** .000 29	1 29	.700** .000 29	.648** .000 29	.482** .008 29
Business Sophistication	Pearson Correlation Sig. (2-tailed) N	.709** .000 29	.809** .000 29	.700** .000 29	.741** .000 29	.700** .000 29	1 29	.829** .000 29	.794** .000 29
Knowledge and Technology Outputs	Pearson Correlation Sig. (2-tailed) N	.611** .000 29	.691** .000 29	.648** .000 29	.681** .000 29	.648** .000 29	.829** .000 29	1 29	.608** .000 29
Creative Outputs	Pearson Correlation Sig. (2-tailed) N	.590** .001 29	.714** .000 29	.482** .008 29	.628** .000 29	.482** .008 29	.794** .000 29	.608** .000 29	1 29

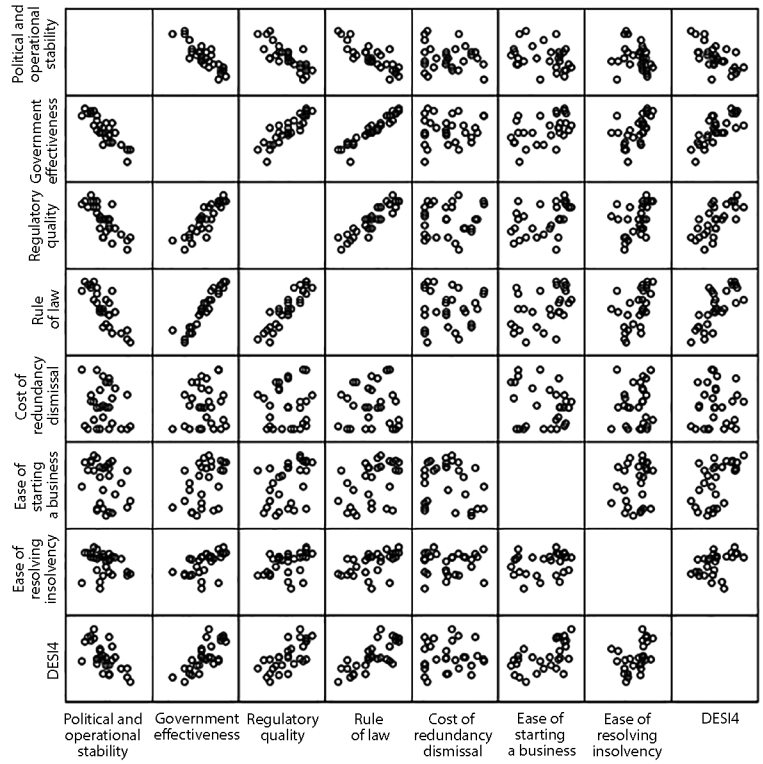

Figure A2. The bivariate links between DESI4 and Institutions sub-pillars of GII and the bivariate links between the Institutions sub-pillars

Table A2. Correlations between DESI4 and Institutions sub-pillars and between Institutions sub-pillars

		DESI4	Political and operational Stability	Government Effectiveness	Regulatory Quality	Rule of Law	Cost of Redundancy Dismissal	Ease of Starting a Business	Ease of Resolving Insolvency
DESI4	Pearson Correlation Sig. (2–tailed) N	1 29	–.640** .000 29	.752** .000 29	.701** .000 29	.756** .000 29	.027 .888 29	.553** .002 29	.451* .014 29
Political and Operational Stability	Pearson Correlation Sig. (2–tailed) N	–.640** .000 29	1 29	–.857** .000 29	–.788** .000 29	–.830** .000 29	–.164 .394 29	–.312 .100 29	–.243 .204 29
Government Effectiveness	Pearson Correlation Sig. (2–tailed) N	.752** .000 29	–.857** .000 29	1 29	.874** .000 29	.947** .000 29	.101 .602 29	.446* .015 29	.532** .003 29
Regulatory Quality	Pearson Correlation Sig. (2–tailed) N	.701** .000 29	–.788** .000 29	.874** .000 29	1 29	.918** .000 29	.052 .789 29	.420* .023 29	.396* .034 29
Rule of Law	Pearson Correlation Sig. (2–tailed) N	.756** .000 29	–.830** .000 29	.947** .000 29	.918** .000 29	1 29	–.004 .984 29	.443* .016 29	.504** .005 29
Cost of Redundancy Dismissal	Pearson Correlation Sig. (2–tailed) N	.027 .888 29	–.164 .394 29	.101 .602 29	.052 .789 29	–.004 .984 29	1 29	–.208 .280 29	.043 .823 29
Ease of Starting a Business	Pearson Correlation Sig. (2–tailed) N	.553** .002 29	–.312 .100 29	.446* .015 29	.420* .023 29	.443* .016 29	–.208 .280 29	1 29	.235 .219 29
Ease of Resolving Insolvency	Pearson Correlation Sig. (2–tailed) N	.451* .014 29	–.243 .204 29	.532** .003 29	.396* .034 29	.504** .005 29	.043 .823 29	.235 .219 29	1 29

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).