

AN ANALYSIS OF THE SPANISH AEROSPACE SECTOR: THE CASE OF THE START-UP ECOSYSTEM IN MADRID

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Abstract

After launching the First Survey on the Spanish aerospace industry, important results were obtained, which helped to delve into the roots of the digital transformation (DT) of this sector, focussing on the Madrid region (Spain). From this type of study, which had not been carried out until now at the regional level, extremely interesting data have emerged that allow us to define the situation of Madrid companies in the aerospace sector. We have characterised and quantified the influence of what we have called ‘transformative enablers’. We have also analysed their relationships with the general characteristics of the companies, such as location, number of employees, legal form or type of company. We also obtained interesting conclusions about the role of respondents within organisations to discover the ‘capillarity’ of their situations and thus understand the degree of DT in terms of whether they achieve the so-called Industry 4.0 (Fourth Industrial Revolution) specifications. Finally, we have carried out a monographic study of the disruptive innovations within the start-up ecosystem to understand its definition and scope in the aerospace industry as a precursor of the latter’s DT.

Keywords: digital transformation; aerospace; start-up ecosystem; enablers; Madrid

Type of the work: review article

1. INTRODUCTION

A search for more Spain-specific approaches to the importance of the start-up ecosystem reveals that this topic is much less addressed. Some general references to the aerospace sector [1] can be found, but with no specific focus on the digital transformation (hereinafter DT). Although various reports have been prepared during the period from 2015 to 2020 by business associations in this sector at the national level, which are very valuable as an explanatory and generalist resource [2], they do not analyse the specific territorial scope of the Madrid Region (Spain) or the subject of DT and its relations. This fact indicates the need for a study to determine the position of the aerospace industry, with particular emphasis on its digitisation and transformations, but from within the heart of the company, from its owners, agents and employees. Herein lies the originality of our work.

Furthermore, this absence of empirical research is even more interesting in the case of one of the regions with the greatest presence of aerospace companies in Spain, namely the Madrid Region, a hub for the leading organisations in the country and the most important start-ups [3]. We will study

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the results of the first survey on DT in the aerospace sector in Madrid, while analysing and describing the situation of the industry in recent years to the present day.

In this regard, an opinion poll was carried out among the Madrid aerospace companies. This survey (i) gave us an insight into the types or elements that play a role in the DT in the companies in the aerospace sector in Madrid; (ii) allowed us to characterise and quantify the so-called ‘enablers’, the transformers or technological features that determine a process of technological efficacy or improvement, which produces the transformation of the industry through the new technologies; and (iii) enabled us to understand their degree of implementation in the respondents’ opinion. We also obtained a general indicator or *degree of DT* (hereinafter DDT) that these companies are considered to have in the view of the people who work in them.

This paper consists of a review that explains the purpose of the study we carried out at the time, with particular emphasis on its originality, as this subject has not been discussed within the most significant doctrinal contributions, or at least not in the aerospace sector or with this focus on the relation between DT and start-ups.

We also discuss the configuration of the study insofar as it consists of a unique survey on the subject, combined with an analysis of the most recent data. We also refer to the motivation for its publication and the interest in conveying these new digital trends in the Madrid aerospace sector to the scientific community. The following sections present an outline of the research and a description of the theoretical basis of our work regarding the very high numbers of companies in the sector in Spain and the special configuration of the aeronautics and space sector in Madrid, with the major subsectors that may also be different industries, although they share the same underlying essence.

We also take an in-depth look at the various conceptualisations of DT and its different logical, semantic and doctrinal approaches, as well as at the so-called digital ‘enablers’, which are indispensable for understanding a study such as this.

This presentation responds to the interest that the aerospace sector arouses in Spain, specifically, in the Community of Madrid, following the research line that I have carried out for some years on the DT in this sector, entrepreneurship, start-ups and their ecosystem. I have recently contributed to a book named ‘Technologies, Business, Innovation, and Entrepreneurship: New Trends and Challenges’, in which I have been able to include part of my research. Now, I am trying to advance a sub-line related to the situation of the start-up ecosystem in the Madrid region and how this affects the momentum of the aerospace sector.

2. THE SPANISH AEROSPACE SECTOR AND ITS TRANSFORMATIVE ENABLERS

This worldwide panorama also influences Spain, and specifically the Madrid Region, which is the focus of our study. Spain is a beneficiary of the significant work being done by the European Union (EU) to promote the aerospace sector through the various activities of the European Space Agency (hereinafter ESA), particularly the efforts of the ESA’s Technology Transfer Programme Office, in the search for innovative ideas to help young entrepreneurs develop space technology, new services and products related with the sector through one of its Business Incubation Centre (BIC), headquartered precisely in Madrid. Madrid is also home to the European Space Astronomy Centre (hereinafter ESAC) and the Deep Space Communications Complex of the National Aeronautics and Space Administration (NASA) in Robledo de Chavela (Madrid), one of only three in the world.

The economic data also offer evidence of the importance of the aerospace sector in Spain: data from 2019 show a turnover of 900 million euros, with the largest volume corresponding to exports, and significantly supported by innovation (11% score billing). Also, worth highlighting are the sector’s 0.5% participation in the industrial gross domestic product (GDP) and its productivity (3%), which is three times the national average.

Focussing on the Madrid Region and on its capital city, there are two factors that explain this territory's emergence as one of the most important national axes in the aerospace sector. In the first place, in 2018, the ESA Space Council gave a significant boost to establishing Madrid as a political and industrial hub in this area. This summit dealt with a range of issues regarding coordination with the EU in the new forms of development of space activities and important matters regarding the competitiveness of the sector, development goals and climate change, among others. Second, in October 2019, Madrid hosted the I Space Congress, an international event that brought together researchers, companies and other agents and served to showcase the activities in Spain and Madrid in space, offering an exciting vision of the future of the sector.

The Madrid Region is also one of the most traditional choices for university education in aeronautical engineering in Spain. It is home to five universities (three public and two private) offering courses that lead to careers in the field of aeronautics and space. Additionally, in 2019, Madrid played host to the first Spanish event of the Space Generation Advisory Council (SGAC), which represents university students and young professionals linked to the space sector before the United Nations and its agencies.

As further evidence of the importance of the Madrid Autonomous Region in the aeronautics and space sector, it should be noted that most companies (64 of the 89 in the employers' association), among them the leading companies in the industry worldwide and in Spain, have offices in Madrid. These include Airbus, Indra, Crisa, Expal, General Dynamics, GMV, Héroux-Devtek, Sener, Tecnobit, Everis, Escribano, CT Engineering Group, Hispasat, Altran, Telespazio Ibérica and Thales Alenia Space. The following airlines also have their head offices in Madrid: Iberia, Iberia Express, Evelop, Plus Ultra and Wamos Air, to name just a few. Madrid also has one of the busiest airports in Spain, the Adolfo Suárez-Madrid-Barajas, with around 425,000 operations a year and almost 560,000 tons of cargo as at the end of December 2019. Additionally, the Region has four military air bases and another 12 air facilities distributed throughout various municipalities around the region.

Very significantly, Madrid is the location of the major aircraft maintenance facilities owned by IBERIA Spain in La Muñiza (Madrid), which will soon become a major aviation eco-tech hub for the relaunch of the airline sub-sector. We will now outline our work, beginning with the important task of defining DT and its various constituent elements as the basic mechanism of transformation in this new digital era [4–8], in which both organisations and society in general are currently immersed.

3. THE START-UP ECOSYSTEM IN MADRID

We will now look at the specific situation of this start-up ecosystem in the Madrid Region, to determine from the qualitative analysis of the results of our study how it is precisely in this area that we are seeing the most significant and far-reaching DT of the aerospace sector for the future development of our industry. Madrid is the fifth most important European destination for start-ups for several reasons, including particularly the low cost of setting up compared to other cities, its rate of economic growth and the attractiveness of risk capital investment [9].

Madrid is also one of the world's most visited tourist destinations and a natural gateway for communications with Latin America, with which it is linked through long-standing historic, linguistic and social bonds. The Madrid Region occupies a privileged position in capital risk investment and represents an already mature innovation environment with a highly qualified workforce and availability of human resources. It has >120 support centres for entrepreneurship and start-ups (accelerators, business incubators, science and technology parks, co-working spaces, venture buildings, etc.) and various educational institutions, universities (notable among which is the Polytechnic University of Madrid [UPM]), business schools, hospitals and other facilities that represent an important boost for the creation of start-ups and their role within open innovation [10] in connection with the whole of the corporate fabric in Madrid.

In economic terms, the activity of the start-ups in Madrid in 2019 was >500 million euros, seventh in Europe in terms of the number of transactions for capital attraction and ninth in total amounts. Five of the main Spanish start-ups have their headquarters in Madrid: Alien Vault, which was bought in 2018 by AT&T for 500 million euros; La Nevera Roja, absorbed in 2016 by the multinational Just Eat, with no precise knowledge of its worth, although it is estimated at >120 million euros; Milanuncios, which was also sold in 2014 to the group Schibsted for a figure of 100 million euros; Paradigma Digital, absorbed in 2018 by Indra for a value of 70 million euros; and Petcoach, also sold in 2017 to PetCo for 10 million euros. This only confirms the excellent position of the Madrid Region in the context of start-ups, as well as secure its place as the main hub of innovative and entrepreneurial development in Spain. A closer look at the investment system for start-ups shows recent and interesting data that define the situation in Madrid. In the first quarter of 2021, the Madrid hub was first in the ranking of investments, with a growth of 4.017.6%, compared to the same period the previous year with a total volume of 746 million euros, more than double that of Barcelona (309 million euros); Valencia and Bilbao lag far behind, with almost 6 million euros and a little >7 million euros, respectively.

To conclude this description of the strength of the current start-up system in Madrid, we must verify the financial structure of these enterprises, which are confirmed as being solid companies with healthy financial situations. It is important to note the relative cash consumption for the whole of the average capital investment, the scrupulous control of debt and the financial needs for the future that evidence the 'muscle' and vigour of these start-ups in Madrid, which would ensure a corporate fabric with high economic value and long-lasting local development compared to other cities in the Iberian Peninsula.

The Madrid Region is also particularly noteworthy for the sectors in which these start-ups operate. According to the latest report on the state of technology in Europe [11], the start-up hub in Madrid is predominantly dedicated to the sector of 'new materials, aerospace, nanotechnology and engineering', and it is a leader in information and communication technologies (hereinafter ICTs) and business software, within which it also has one of the largest clusters of initiatives, products and services in the field of data analysis and artificial intelligence (hereinafter AI).

All this information goes to confirm the line that we highlighted in the sample part of our study and indicates that the start-ups in the aerospace industry are serving as the basis for development in the industry by fostering DT, compared to other companies that are too large to undertake these transformations.

We now discuss the human potential in the Madrid Region. If there is one element that defines the importance of start-ups in Madrid and its ecosystem, this is undoubtedly its human resources both in the development of information technology (IT) applications and in science, technology, engineering and mathematics (hereinafter STEM subjects) at the degree level. Since 2019 to the present day, Madrid has been the indisputable leader of the Cotec Foundation for Innovation and the Valencian Institute for Economic Research (COTEC-IVIE) ranking of innovative talent in Spain [12], as it is the autonomous region with the greatest capacity to attract and retain talent according to the adaptation of the Global Talent Competitiveness Index (GTCL), now with a post-coronavirus disease-2019 (COVID-19) methodology. It scores a maximum in the six pillars of the new indicator: enable, attract, grow, retain, capacity and technical vocations and knowledge.

Madrid is also seventh in Europe in the number of IT developers. However, the most significant factor is the very clear head start that Madrid has in the number of young people aged between 25 years and 34 years with university studies or higher, with 54.6%, 7.2% higher than the European average. When applied to start-ups, this implies that six out of every 10 start-up founders have a higher university degree, and a quarter of these founders have created more than three start-ups. All this gives a satisfactory idea of the high levels of training, skills and experience offered by the human capital behind Madrid's start-up-and-innovation ecosystem and endorses the Madrid Region as a highly solvent location for the development of innovation, technological advances and research, development and innovation

(R&D&I) [13]; this situation will continue in the future even after the crisis, as it has already recovered its previous levels of investment and employment [14].

After the previous year's pandemic and the ensuing economic situation, in 2021, the prestigious start-up ecosystem in the Madrid Region described above culminated the year by winning the European Committee of the Regions' European Entrepreneurial Region award 2021–22, a seal of excellence awarded to only eight regions in the whole of the EU for their outstanding entrepreneurial vision, for establishing a strategy of intelligent growth and for its concern for the social and ecological situation of the territories. Madrid has also been recognised for its capacity to reorient the development of the local economy—despite the serious effects of the crisis—towards the European guidelines on small and medium-sized enterprises (SMEs), for the mobilisation of resources for recovery after the pandemic and for the sustainability of the system that guarantees a development that is compatible with quality of life and economic growth and is highly susceptible to extrapolation to the aerospace industry, one of the strategic sectors for Madrid.

4. THE TRANSFORMATIVE ENABLERS

The prime reference in the world of DT is digital technologies. These must be analysed in depth, particularly if we want to gain a better understanding of what we mean when we refer to DT. Here, we will be guided by one of the most exhaustive studies available, that of Bharadwaj et al. [15], who considered what these technologies involve and defined the framework for future research on DT. This author also established and characterised the following digital technologies:

- a) Technologies that change the traditional commercial strategy through 'new business processes that are modular, distributed, multifunctional and global', which make it possible to work beyond time, space, distance and functional limits.
- b) Technologies that give rise to new functionalities in information, communication and connectivity, at lower prices.
- c) Technologies that adapt the business infrastructure to the new digital era through new Internet or mobile Web protocols.
- d) Technologies that allow different ways of effectively using the functionalities of these technologies for 'turbulent environments' [16] (organisations with unexpected and unpredictable changes).
- e) Technologies that transform the structure of the relationship between consumers and companies through the communications media or social networks.
- f) Technologies based on digital platforms that allow disruptions in the organisations that favour new business models.
- g) Technologies that represent exponential advances in price due to increased computing, storage, bandwidth or cloud computing performance.

Whenever we describe the DT—as this is a constantly changing transformation—we will need to refer to the new trends in technologies and to society's so-called 'enabling solutions' and ITs [17]. This is the source of all the considerations about the technological 'enablers' that are so important in DT and that have determined the main hypothesis of this study, by including them in the survey in our work and then by irrevocably linking them to the implementation or not of DT.

5. METHODOLOGY

To obtain the data, we designed an anonymous survey during late 2019 and early 2020 to interrogate the various agents in the business world in the Madrid aerospace sector about their opinion of the technological reality they were experiencing regarding a possible DT, especially in terms of enablers.

Our aim was to eliminate any implication from the results, either due to the provenance of the survey (senior management, managers or other areas) or any other conditioning factor that might affect the respondents, albeit unconsciously. We therefore found certain independence in the answers, as they were not identified with any promoter of the surveys or any other distorting element. This survey was launched through digital media, especially social networks, and allowed a total of 105 responses, with which we have a significant representation since the total number of companies in the aerospace sector in the Madrid region rises to 252 (n=252) according to the data of the National Institute of Statistics of Spain (INE¹) and the Statistical Centre of the Community of Madrid. This assumes a confidence level of 95% for an error <6.

The survey was entitled ‘First survey on the digital transformation in the aerospace industry in the Madrid Region’ and was conceived as an academic research study on the DT by sectors. The respondents were informed that it focussed on the aerospace industry in general, but within the geographic scope of the Madrid Region. It was presented with the aim of trying to understand the situation in this sector and its journey towards an Industry 4.0 (Fourth Industrial Revolution) entity. It was stated in the survey that all the data would be treated anonymously; in fact, the respondents were asked for no personal details, and neither they themselves nor the company they worked for, managed or owned could be identified in any way. They were also informed that the data would be processed only for the purposes of statistical analysis and for the scientific dissemination of their results, and the data processor was specified.

This is the most important part of the survey and of our work and is dedicated to the so-called ‘enablers’ of DT. Question 9 is intended to determine the degree of acquisition, implementation or use of these enablers that allow the development and achievement of the DT. As in the rest of the survey, there is an open field entitled ‘Another digital enabler not mentioned (please specify)’ to gather any information not included either in the empirical literature or in the current experience. The scoring is done by means of an extended quantitative scale of 1–10 on an increasing gradient from ‘Least implemented or used’ to ‘Most implemented or used’.

Table 1. Digital transformation enablers based on the survey design.

Number	Enabler	Acronym in the study	Average enable score
1	e-Commerce	CE	5.72
2	Digital Marketing	MD	5.91
3	Digital relationship with clients, suppliers, or stakeholders	RD	6.77
4	Big data	BD	6.25
5	User experience mobile	UE	5.51
6	Mobile technology (5G)	CG	4.19
7	Machine learning	ML	5.73
8	Cloud computing	CC	6.13
9	Cloud Storage	CS	6.80
10	Blockchain or distributed ledger technology	BC	4.61
11	Cyber security	CBS	6.67

¹ www.ine.es; <https://es.statista.com>; <https://www.madrid.es> and <https://www.comunidad.madrid>.

12	Artificial intelligence (IA)	IA	5.71
13	Internet of things (IoT)	IoT	5.51
14	Augmented reality (AR)	RA	4.51
15	Virtual reality (VR)	RV	4.53
16	Additive manufacturing	FA	4.99
17	Robotic	RO	5.99
18	Agile methodologies	MA	6.10
19	Digital talent	TA	6.07
20	Entrepreneurial or innovative digital ecosystem	ED	5.45
21	Digital culture	CD	6.10
22	Top-down strategy	DT	5.62
23	Capital or financing of innovation	CI	5.93
24	Other digital means of organizational and productive efficiency	O	5.91
25	Another digital enabler not mentioned (specify)	A	-

Table 1 shows the enablers that are analysed. The table also includes the average degree or score to aid observation, although later in the Results section, this issue is discussed, and visual graphics are provided at this level.

6. RESULTS

The two most important variables in our statistical study are the implementation rate of the DT enablers and, without doubt, the DDT or general indicator (degree of TD) in the Madrid Region for the aerospace sector. Figure 1 shows the situation of these enablers for all the companies, with their average values ordered from highest to lowest (unordered values in Table 1).

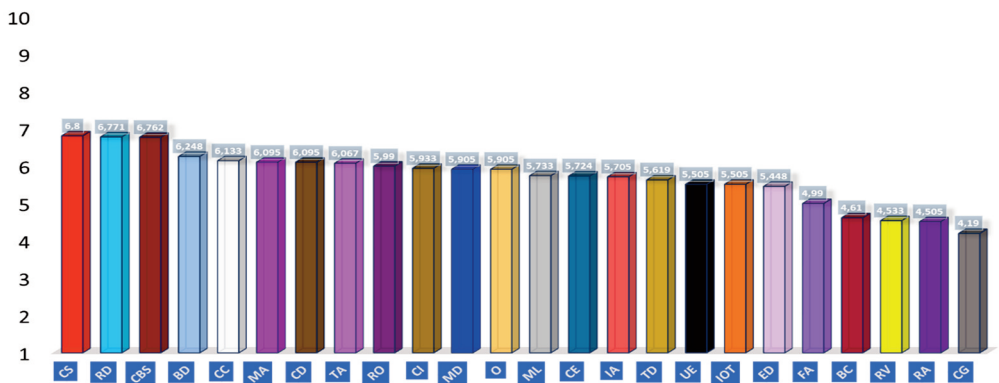


Figure 1. Rate of implementation of DT enablers in the aerospace industry in the Madrid Region: average values; prepared by the author. DT, digital transformation.

On first observation, these scores are mostly >5, except the last five, which can be said not to reach a satisfactory level in terms of their implementation in the respondents' companies. These five enablers are additive manufacturing, blockchain or distributed ledger technology, virtual reality (VR), augmented reality (AR) and mobile technology (fifth-generation mobile network [5G]). This is highly significant insofar as these enablers have a very current application and are widely known by the public and of course by the specialists, although this has not filtered through to the sphere of the organisations in our study. On the opposite side are three enablers that have been very widely implemented (namely cloud storage; digital relationship with clients, suppliers and stakeholders; and cybersecurity), which curiously are the ones most easily applied by the companies and which also account for maximum utility and concern for them, as they involve questions of data storage, experience and digital relation with clients and other stakeholders, apart from cybersecurity.

However, the most interesting aspect of our work is the comparison with the average rate of these enablers depending on whether the company in question is a large enterprise or a start-up (Fig. 2, dark blue for start-ups and light blue for large companies) and with, of course, the total perceived total DDT (dark green for start-ups and light green for large companies). This total level or DDT is measured on a scale of 1–5, where '1' is the lowest and '5' is the highest. All this leads us to understand at a single glance that the start-up model far exceeds the large companies in DT.

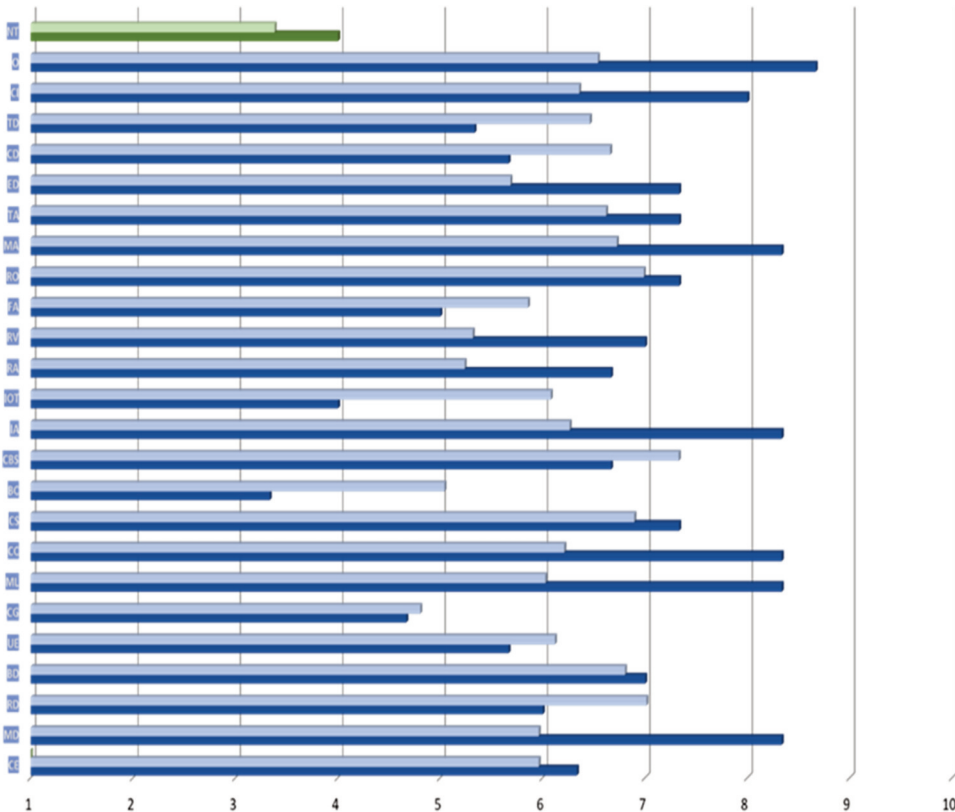


Figure 2. Rate of implementation of DT enablers in the aerospace industry in the Madrid Region: average values; prepared by the author. DT, digital transformation.

Notes: It is difficult to include a graph that contains all the enablers and is easily readable, but what is important is the visual set of the graph. All the results are described in detail in Table 1.

It is clear that the average implementation values of all the enablers are higher for start-ups and, sometimes, double the rates for the large companies, which absolutely refutes our study, as the DT penetrates better and faster among start-ups than among large companies. This confirms that according to the data, the start-ups in the aerospace industry in the Madrid Region are more connected and more digitally transformed than the large companies. It is worth mentioning the enablers in the start-ups that are notable for their high degree of implementation: digital marketing, machine learning, cloud computing, AI, agile methodologies, other digital resources for organisational and productive efficiency, and above all—one of the most important enablers in DT—capital or financing of innovation, an area where start-ups are substantially ahead of large companies.

We conclude our results on the empirical data with Fig. 3, showing the rate or DDT in the companies surveyed in the Madrid aerospace industry and their average values on a map of the region, showing the municipalities in Madrid ordered from highest to lowest in DT, from a score of '5' for the highest DT and '0' for the lowest. As can be seen, the highest results in DT are found in the municipalities of Alcobendas, Arganda, Las Rozas and Getafe. In the middle range are San Sebastián de los Reyes, Madrid City, Villaviciosa de Odón, Ajalvir and Tres Cantos, while Torrejón de Ardoz scores zero in DDT.

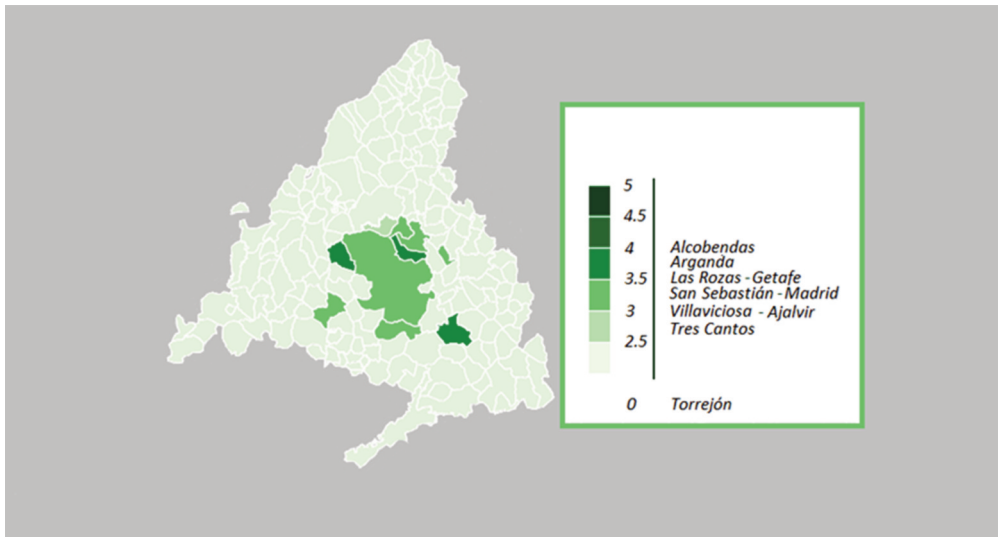


Figure 3. Map of the Madrid Region and its municipalities with the total DT rate in the aerospace industry, ordered from highest to lowest; prepared by the author. DT, digital transformation.

As described in the previous paragraph, in the Community of Madrid, the DT is not only centralised in the capital but is distributed in the metropolitan belt around the city, coinciding with the municipalities that are home to the main companies in the sector (or companies linked in some way to the industry), business development in these areas, access to infrastructures or proximity to airports, and the presence of historical aeronautical bases or facilities such as Alcobendas, Arganda, Tres Cantos and Getafe Airport.

CONCLUSIONS

An important factor that we have highlighted is that for DT to occur, there needs to be a rate of implementation of certain technological enablers to encourage the far-reaching changes that lead to the DT and to learn which are the most important, to the point of proposing an exhaustive list to serve as a focus for companies and even for future analyses or studies.

This confirms that all DT must involve modifications and alterations through commercial movements with a strategic and tactical nature, producing a trigger or an outcome that must be linked to an evolution in data science, as the only way of bringing about the wholesale digitisation that we have described in our analysis.

Our study describes the characteristics of the digital technologies that need to be implemented in the DT and concludes that they must have different features, but particularly those that favour disruptions in companies and provoke new business models. Our work has been extremely edifying as it has allowed us to distinguish these technological solutions—both at the present time and for new research in the future—identifying them as transformative and characteristic of a DT in the sector that is the focus of this study.

We have observed that in the fabric of the Madrid aerospace industry, there is a very significant distance between large companies and start-ups, which could possibly mean that the sector is insulated from the disruption and innovation that most often stems from start-ups. Another finding is the lack of support for these large companies and for smaller more-disruptive companies to build an auxiliary or supplementary industry that could represent a more significant advance for the whole of this ecosystem together.

In the important aspect of the rate of use or implementation of the enablers in DT, we have reached very significant conclusions for understanding the situation in Madrid. All 24 enablers studied scored above 5 (>5) on a scale of 1–10, indicating a pass rate in digitisation, and the three highest-scoring areas are: (i) cloud storage, (ii) digital relationship with clients, suppliers or stakeholders and (iii) cybersecurity. This suggests that, in general, the enterprises studied have concentrated on the enablers that are closest to their greatest needs for digital adaptation than on those that lead to a real DT.

We also observed that certain enablers with a highly technological component are more difficult to achieve, so companies are yet to undertake this type of transformation. This is the case of the enablers dedicated to additive manufacturing, blockchain or distributed ledger technology, VR, AR and mobile technology (5G). There are certain possible theories as to why this might be. Some theories consider that these enablers have a greater cost or are not fully developed, while others maintain that they are technologies that clearly define what differentiates the DT from the mere application of technologies and that, as a result, companies have been unable to apply them to their processes. Our own opinion is that there is a much easier explanation, namely that these enablers require maximum disruption and innovation, and that large companies do not need to devote their efforts and resources in the same way that start-ups can and must, whose very nature means they are forced to use them to survive.

Evidence of this is that, unquestionably, one of the most important aspects of our study is the comparison of the rates of enablers between large companies and start-ups, which reveals that the rates of utilisation of enablers are always greater in start-ups and are even double those of large companies, indicating that it is precisely the start-ups in the region that are assuming most DT and are best placed to transfer these disruptions to the remaining companies.

This type of company has achieved high rates in the enablers for digital marketing, machine learning, cloud computing, AI, agile methodologies and other means of organisational and productive efficiency. Another particularly revealing fact is that our study found a high rate of development in the enabler for capital or financing of innovation.

Finally, we have determined that the start-up ecosystem in Madrid is highly consolidated. This will be of great help in the future for ensuring consistency among and renovation for these start-ups, which are charged with powering the transformative development of society in the region. The start-up ecosystem in the Madrid Region is one of the strongest and most innovative in the country and is among the top-ranking in the whole of Europe. This is a very important facilitating element of DT, based precisely on the existence and proliferation of start-ups as resources, to achieve these unique and radical changes in the aerospace sector.

References

- [1] Lenorovitz, J.M. "Spain to Modernize Aerospace Industry." *Aviation Week & Space Technology*, Vol. 120 No. 4 (1984): pp. 93–96.
- [2] TEDAE. *Memoria de Actividades 2018*. Madrid (2019). [Online]. Available: https://www.tedae.org/uploads/files/1642594858_memoria-tedae-2018-pdf.pdf
- [3] Fundación para el Conocimiento Madrid. *Startup Radar Madrid 2020*. Madrid (2020).
- [4] Campo Vidal, M., Alberich Pascual, J., and Roig Telo, A. *ProQuest. Comunicación audiovisual digital*. Editorial UOC, Madrid. (2005).
- [5] Martín, J.A.J. "La era digital: nuevos medios, nuevos usuarios y nuevos profesionales." *Razón y palabra* Vol. 71 No. 42 (2010). <https://dialnet.unirioja.es/servlet/articulo?codigo=3791863>.
- [6] Díaz, V. M., and Lombardero, L. *Trabajar en la era digital. Tecnologías y competencias para la transformación digital*. Editorial Empresarial. Madrid. 2015. [Online]. Pixel-Bit. *Revista de Medios y Educación*, No. 49 (2016): pp. 243-244. Available: <https://dialnet.unirioja.es/servlet/articulo?codigo=5769620>.
- [7] Ramírez Morales, A. *Digitalizate o desaparece: claves para transformarse y competir en la nueva era*. Gestión 2000, Barcelona. (2017).
- [8] Mergel, I., Edelmann, N., and Haug, N. "Defining Digital Transformation: Results from Expert Interviews," *Government Information Quarterly* Vol. 36 No. 4 (2019): p. 16. DOI 10.1016/j.giq.2019.06.002.
- [9] Bankinter, F.I. "Informe trimestral. Observatorio del Ecosistema de Startups: Tendencias de inversión en España Q1 2020". Madrid. 2021 [Online]. Available: <https://www.fundacionbankinter.org/wp-content/uploads/2021/07/Observatorio-Startups-Informe-1Q-2020.pdf>.
- [10] Spender, J.-C., Corvello, V., Grimaldi, M., and Rippa, P. "Startups and Open Innovation: A Review of the Literature," *European Journal of Innovation Management* Vol. 20 No. 1 (Jan. 2017): pp. 4–30. DOI 10.1108/EJIM-12-2015-0131.
- [11] Atomico, Slush, and Orrick. "The State of European Tech." 2019. [Online]. Available: <https://2019.stateofeuropeantech.com/chapter/about/>.
- [12] Mas, M., Quesada, J. and Pascual, F. "Mapa del talento en España 2019." Madrid. 2019. [Online]. Available: <https://cotec.es/observacion/mapa-del-talento-autonomico-2019/ceb4f848-ff50-4219-b571-3d0cb84b765f>.
- [13] Madrid Innovation Driven Ecosystem, Universidad Politécnica de Madrid, and Impact Hub Madrid. "Radiografía De La Innovación Y El Emprendimiento En La Comunidad De Madrid." Madrid. 2020. [Online]. Available: <https://www.mide.global/biblioteca-virtual.php>.
- [14] COTEC. "Cuando la pandemia llegó, España presentaba una importante brecha con Europa en I+D." Madrid. (2020).
- [15] Nadeem, A., Abedin, B., Cerpa, N., and Chew, E. "Editorial: Digital Transformation & Digital Business Strategy in Electronic Commerce - The Role of Organizational Capabilities," *Journal of Theoretical and Applied Electronic Commerce Research* Vol. 13, No. 2 (2018): pp. I–VIII. DOI 10.4067/s0718-18762018000200101.
- [16] Pavlou, P.A., and Sawy, O.A. "From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development," *Information Systems Research* Vol. 17 No. 3 (2006): pp. 198–227. DOI 10.1287/isre.1060.0094.
- [17] Heilig, L., Schwarze, S., and Voß, S. "An Analysis of Digital Transformation in the History and Future of Modern Ports," 2017. Digital transformation, aerospace, start-up ecosystem, enablers, Madrid.