IT & DATA SCIENCE SECTOR

AN IN-DEPTH OVERVIEW OF THE IT & DATA SCIENCE SECTOR IN BRABANT

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Brabant, the Netherlands – An in-depth analysis of its IT & Data Science Sector',
a publication of the Brabant Development Agency (BOM), Tilburg, the Netherlands

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PUBLICATION DATE

November 2021

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maan identity. design. content. - Ulvenhout

1. INTRODUCTION TO THE STUDY

IT & Data Science sector in Brabant - An in-depth overview

Dear Reader,

We at the Brabant Development Agency (BOM) are proud to present to you our new in-depth overview of the IT & Data Science sector in Brabant. The goal of this report is to provide you with a detailed outline of the IT & Data Science sector in the province, including the strengths and opportunities the region has to offer. The Brabant IT & Data Science sector consists of 10,490 businesses and employs a total of 42,630 people. The province is home to 13.2% of all IT & Data Science Dutch-based companies and 12.1% of its jobs.

But the evolution of information technology is not only limited to the IT & Data Science or tech sector, as today software is an integral part of every industry. This is particularly true for those industries that Brabant is famous for – HTSM, AgriFood, Life Sciences & Health, Mobility, and Logistics. All those sectors are fully committed to embracing and exploiting the benefits of IT and Data Science technologies, such as AI, to become future-proof and remain competitive on the world stage. Brabant-based companies are well known for quickly adopting new advances and innovations and applying them. A large proportion of staff in these industries is also involved in IT and Data Science, with around 79,000 IT professionals employed in Brabant – 14% of all IT jobs in the Netherlands.

As a knowledge-intensive sector, IT & Data Science depends heavily on talent resources, and the flourishing IT & Data Science ecosystem has driven up demand for talent even further. Talent and bright minds make all the difference in the province's knowledge economy, and that will continue to be the case. Brabant has spent decades investing heavily in prioritizing the knowledge economy and associated talent, an investment that is paying off. One of the key strengths of the region is the steady growth of a range of excellent universities, knowledge institutes, and other educational bodies in IT & Data Science as well as the talent that emerges from them. With over 3,400 IT & Data graduates in 2020, nearly 2,500 of whom have bachelor or master degrees, the Brabant region is the principal source of highly educated IT talent in the Netherlands.

Moreover, the numerous commercial campuses and knowledge institutes, both general and applied, also play an essential role. These campuses are home to many IT and Data Science field labs where researchers, students, entrepreneurs, and companies work together to accelerate IT & Data Science innovation for a specific industry or application. Thanks to the close involvement of researchers, the industry, government agencies, and end-users, those innovations are introduced to the world at a faster pace than would otherwise be the case, a factor that holds true both today and in the future. Thanks to these joint ventures, Brabant is home to one of the smartest and most innovative IT and Data Science clusters in the world. The Brainport Eindhoven region is Europe's prime innovation cluster in terms of data technology patents, such as the Internet of Things (IoT), Big Data, 5G, and artificial intelligence (AI). In global rankings Eindhoven takes 15th place.

So, who are we? We are the Brabant Development Agency. Based in Tilburg, our BOM Foreign Investments & International Trade department assists new and existing foreign companies to make optimal use of the opportunities offered by Brabant as a business location. We also provide hands-on support to companies based in Brabant that are growing their business abroad.

We hope you will enjoy reading this in-depth review, and if you would like to know more about what Brabant has to offer, please feel free to reach out to us!

With kind regards,

Guido Leestemaker - Project Manager Foreign Investments - IT & Data Science
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Introduction

The purpose of this study is to provide a comprehensive overview of the IT & Data Science sector in Brabant, including international trends and developments as well as the priority niches. The report is laced with profiles of inspirational regional and national players in the world of IT & Data Science.

Our primary target audience is professionals with an interest in the IT & Data Science sector, representatives of companies already established in Brabant or those with an interest in doing so, as well as investors from the Netherlands or abroad or innovation partners in the Brabant IT & Data Science network. The report is also of value to specific national, regional, or local government agencies, industry organizations, economic development agencies, and media companies that wish to gain further insight into the region and the industry. The review is based on desk research, extensive data-analysis, stakeholder and sector-specialist interviews, and intensive cooperation between the authors and BOM representatives and its key partner organizations in Brabant. The report contains Brabant-specific facts and figures but is written with the clear understanding that the IT & Data Science sector is a global industry where regional and even national borders are of little importance. That is why the report treats the province of Brabant as embedded within the wider perspective of the Netherlands, operating in the global market.

This review aims to give the reader an accurate profile of what Brabant has to offer. While we have strived to make this study as complete and accurate as possible, we always appreciate hearing readers' comments and thoughts, as they are valuable for future editions of this document. We hope this study will provide valuable insights and prove to be an entertaining read.

Above all else, we hope it provides the stakeholders in the IT & Data Science sector with a range of tools, including the following:

- A *looking glass* to see the important sector details
- A *helicopter* to see the bigger picture across regional and national borders and across society as a whole
- A *compass* to help determine the future strategic direction of the industry in key enabling technologies and in areas of application
- *Scales* to help prioritize, choose, and focus
- A *crystal ball* providing inspiration to work together and to invest time, effort, and money in developing IT & Data Science solutions for a more sustainable and happier future society

We would like to acknowledge and thank all our contributors for the input they provided. It would have been absolutely impossible to create this report without them.

Henry de Vaan, Fanion Onderzoek & Advies

2. INTRODUCTION TO BRABANT, THE NETHERLANDS

A. What has Brabant got to offer?

The Dutch province of Noord-Brabant is located in the southern part of the Netherlands, strategically situated between Amsterdam Schiphol Airport, Europe's leading seaport in Rotterdam, the Port of Antwerp, Brussels, and the major German economic heartland of the Rhine-Ruhr region. Brabant covers an area of 5,082 km^2, making it the second largest province in the Netherlands, and is home to some 2.5 million people spread across 62 municipalities.

- From a geographic perspective Brabant offers easy access to 170 million Europeans within a 500 km (310 mi.) radius. Physical and telecommunication infrastructure are best-in-class when it comes to establishing head offices and/or marketing & sales, R&D, manufacturing, and logistics operations.

- Costs-wise, the Netherlands has a favorable corporate tax regime in comparison to most European countries.

- Research, product, and process development and manufacturing are in Brabant's DNA. Ranging from primary production in agriculture and the food industry to the manufacture of semifinished products, all the way through to OEM production of the most complex electronic, biopharmaceutical, nutraceutical, and IT products and equipment – all these activities can be found in the region in abundance.

- The well-developed industrial and knowledge networks or "ecosystems" in High-tech Systems, IT & Data Science, Logistics, Life Sciences & Health, AgriFood, Chemicals, and Aerospace offer opportunities for cooperation at a very high level. Cross-industry partnerships in the region are a given.

Source: BOM, Info & Graphics

Figure 1: Brabant Strategic Located

B. Brabant's main benefits

The province of Brabant offers the famed Dutch business-friendly environment as well as a number of favorable geographical advantages:

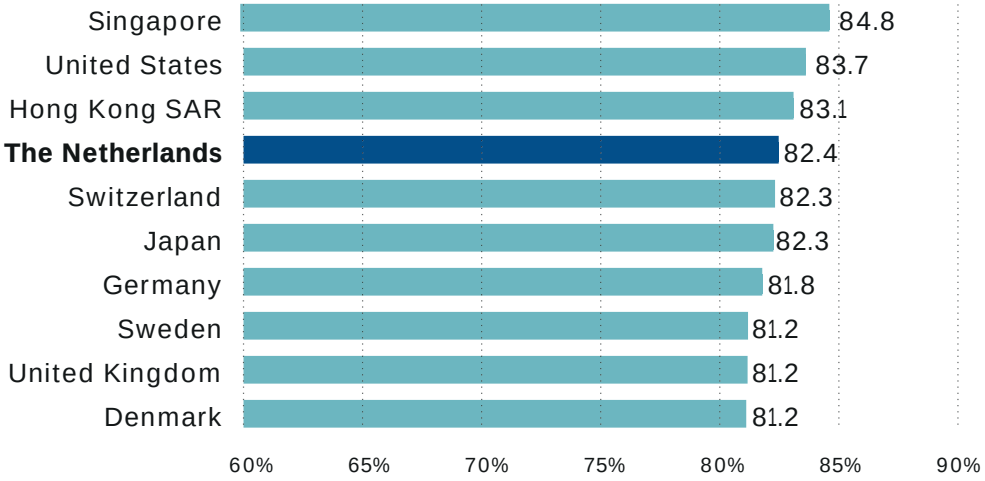
The Netherlands as a whole, and Brabant specifically, offer:

- an attractive tax climate, including personal and corporate income tax and value-added tax (VAT)
- a stable economic, political, and social climate
- competitive labor costs

Brabant is particularly well-located in Europe thanks to:

- its easy accessibility
- its excellent infrastructure

As a whole, time and again, the Netherlands – with Brabant at its innovative heart - proves to be a highly competitive economy on a global scale!



Graph 1: The Global Competitiveness Index

THE NETHERLANDS, ONE OF THE WORLD'S MOST COMPETITIVE ECONOMIES (WORLD ECONOMIC FORUM (2019) – THE GLOBAL COMPETITIVENESS REPORT 2019

C. Brabant's main cities

Covering 5,000 square kilometers (2,000 square miles), almost 15% (2.5 million inhabitants) of the Dutch population lives in Brabant. The capital of Brabant is Den Bosch, while its largest city is Eindhoven, followed by the cities of Tilburg, Breda, Den Bosch and Helmond.

Source: BOM, Info & Graphics

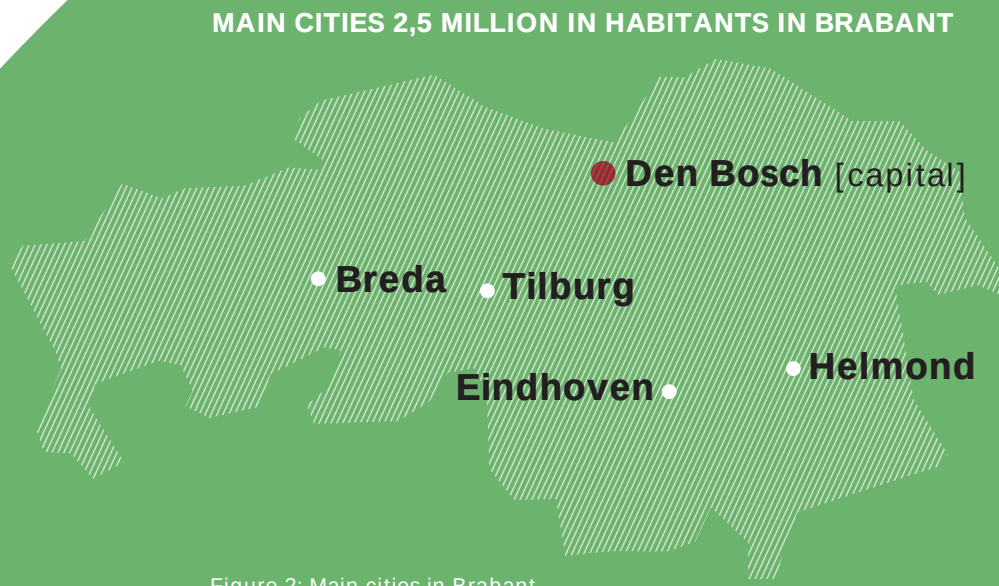


Figure 2: Main cities in Brabant

D. Brabant: industry, science, and innovation

Brabant is a productive, highly industrialized, and knowledge-intensive province in the Netherlands, and as such is a magnet for companies looking for (partnerships in) the fields of industrial innovation and/or state-of-the-art manufacturing.

In fact, Brabant is the most R&D-intensive region in the Netherlands and one of the most innovative regions in Europe, as aptly illustrated by the following three facts:

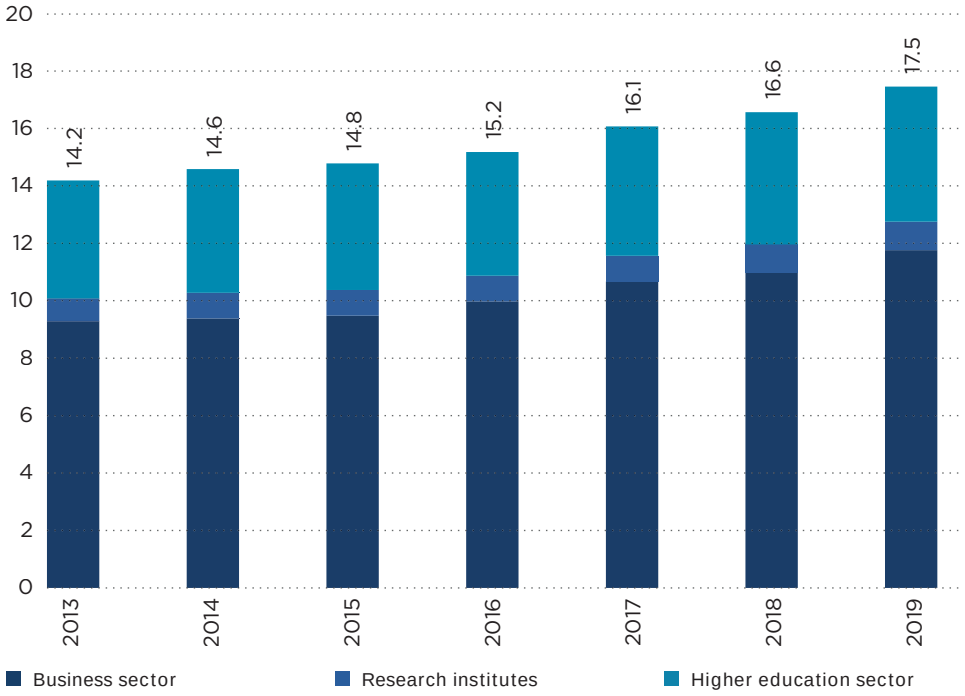
1. **30% of all industrial R&D in the Netherlands is undertaken in Brabant**
2. **Over 50% of all Dutch European patent applications are generated in Brabant**
3. **Brabant holds fifth place in Europe on the list of regions with the highest number of patent applications**

With over 34,000 people engaged in R&D activities, Brabant can provide the necessary brainpower, readily delivered by its bright people and numerous research and educational institutions. Geographical clustering enables cooperation between businesses, universities, and governmental research bodies. Joint R&D projects result in a mutual bolstering of strengths and inspiration and involves sharing technological knowhow and expensive research facilities, as well as joining forces in EU and other technology programs. The distinctive collaborative research style is the secret to significantly advancing R&D and innovation activities.

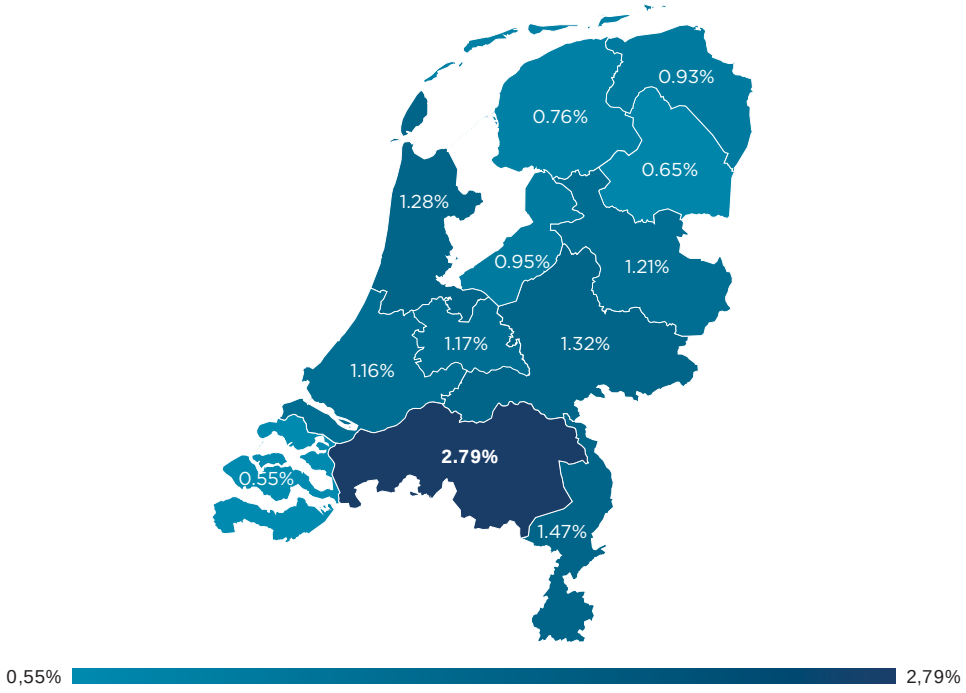
1. Putting R&D expenditure in Brabant into perspective

In 2019, total R&D expenditure in the Netherlands amounted to more than 17.5 billion euros. Brabant is home to the largest share of R&D activity out of all the nation's provinces, accounting for over 30% of total private R&D spending in the Netherlands. Total private R&D expenditure as a proportion of the regional gross domestic product stood at 2.79% in 2018 – over double the national average of 1.19%.

R&D EXPENDITURE IN THE NETHERLANDS



PRIVATE R&D EXPENDITURE (PERCENTAGE OF GDP) IN 2018



In Europe, North Brabant ranks 13th out of 281 NUTS 2 regions in terms of private R&D intensity. While the other Dutch provinces don't even make the top 50, private R&D intensity in the Netherlands is slightly above the EU average. The data refer to 2017; for 2018 figures are not yet available for some R&D intensive regions.

2. Putting patent applications in the Netherlands into perspective

In 2020, 6,375 patents were filed in the Netherlands. This puts the Netherlands in eighth place in the world for countries that applied for patents with the European Patent Office (EPO), while it takes fourth spot in Europe.

Rank	Country[2]	2019	2020	% chance 2020/2019
1	Germany	26,762	25,954	-3.0%
2	France	10,233	10,554	3.1%
3	Switzerland	8,266	8,112	-1.9%
4	**Netherlands**	**6,942**	**6,375**	**-8.2%**
5	Italy	4,469	4,600	2.9%
6	Sweden	4,395	4,423	0.6%
7	Denmark	2,415	2,404	-0.5%
8	Belgium	2,422	2,400	-0.9%
9	Austria	2,346	2,303	-1.8%
10	Finland	1,705	1,895	11.1%

When comparing the number of patents per million inhabitants, the Netherlands is still in fourth place in Europe.

Rank	Country[5]	Applications 2020	Population[6] (mil. inhabitants)	Applications per mil. inhabitants
1	Switzerland	8,112	8,398	965.9
2	Sweden	4,423	10,186	434.2
3	Denmark	2,404	5,869	409.6
4	**Netherlands**	**6,375**	**17,274**	**369.1**
5	Finland	1,895	5,572	340.1

3. Putting patent applications in Brabant into perspective

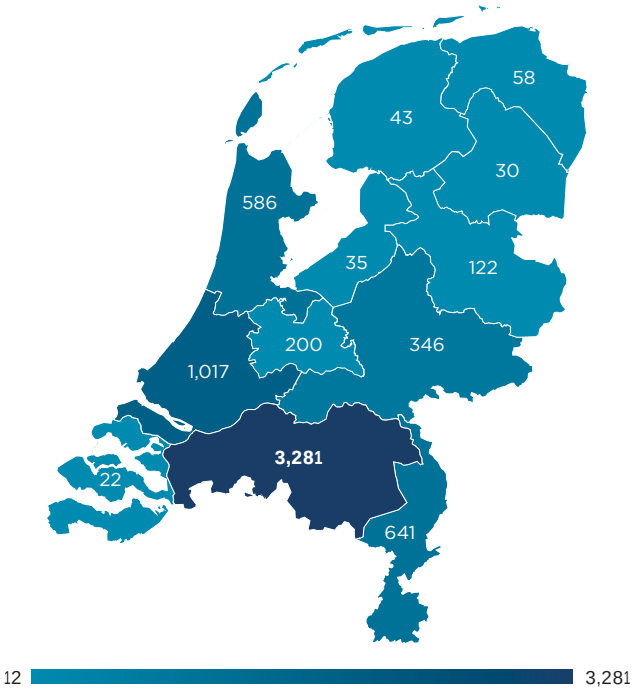
Royal Philips was again the most active patent applicant in the Netherlands with the EPO in 2020, with 1,419 patent applications. After Siemens and Ericsson, it is the third-biggest patent applicant in Europe and eighth biggest in the world.

At a national level, Philips is followed by Signify (formerly Philips Lighting) with 691 applications, DSM with 348, Airbus with 327, NXP with 310, and ASML with 308.

The province of Brabant leads the Dutch field for European patent applications, with its share having grown to 51.5%. The region also held fifth place out of all the European regions filing patent applications with the European Patent Office in 2020.

Province	2020	Share of total applications	2019	Share of total applications	% change 2020/2019
Brabant	3,281	51.50%	3,752	54.00%	-12.60%
South-Holland	1,017	16.00%	1,009	14.50%	0.80%
Limburg	641	10.10%	610	8.80%	5.10%
North-Holland	586	9.20%	697	10.00%	-15.90%
Gelderland	346	5.40%	390	5.60%	-11.30%
Utrecht	200	3.10%	211	3.00%	-5.20%
Overijssel	122	1.90%	120	1.70%	1.70%
Groningen	58	0.90%	46	0.70%	26.10%
Friesland	43	0.70%	40	0.60%	7.50%
Flevoland	35	0.50%	35	0.50%	0.00%
Drenthe	30	0.50%	26	0.40%	15.40%
Zeeland	12	0.20%	6	0.10%	100.00%
Unclassified	4		0		
Total	6,375		6,942		-8.20%

PATENT APPLICATIONS IN THE NETHERLANDS



On the European stage, Brabant ranked fifth in 2020 in the list of regions with the highest number of patent applications.

LEADING EUROPEAN REGIONS FOR PATENT APPLICATIONS AT THE EPO IN 2020

	Region	Country	2020	Change
1	Bayern	DE	7,204	-7.6%
2	île-de-France	FR	6,507	-0.1%
3	Badem Württemberg	DE	5,421	+0.9%
4	Nordhein-Westfalen	DE	5,047	-4.5%
5	**North-Brabant**	**NL**	**3,281**	**-12.6%**
6	Stockholm	SE	2,382	-0.3%
7	Greater London	GB	1,973	-3.3%
8	Niedersachsen	DE	1,969	+9.9%
9	Hessen	DE	1,851	-9.2%
10	Rheinland-Pfalz	DE	1,820	+4.2%
11	Vlaanderen	BE	1,580	+1.7%
12	Lombardia	IT	1,538	+3.0%
13	Auvergne-Rhône-Alpes	FR	1,463	+10.2%
14	Helsinki-Uusimaa	FI	1,460	+19.8%
15	Hovedstaden	DK	1,402	+3.3%
16	Vaud	CH	1,142	+8.7%
17	South Holland	NL	1,017	+0.8%
18	Basel-Stadt	CH	966	+1.4%
19	Zürich	CH	953	-9.2%
20	Aargau	CH	920	-3.9%
21	South East England	GB	909	+2.0%
22	Västsverige	SE	815	+16.4%
23	East of England	GB	799	+3.9%
24	Genève	CH	780	+30.0%
25	Emilia-Romagna	IT	771	+3.6%

Source: European Patent Office 2021

E. Facts and figures

1. DEMOGRAPHY

Population, 01-01-2021
Brabant 2,573,949 (14.7%)
The Netherlands 17,474,417 (100%)

Population growth in 2020
Brabant 0.39%
The Netherlands 0.42%

Population density in km²
Brabant 525
The Netherlands 519

Non-Dutch population, 2020
Brabant: 163,035 (6.4%)
Netherlands: 1,192,309 (6.8%)

Age distribution

	The Netherlands	Brabant
0 - 14	15.5%	14.9%
15 - 64	64.7%	64.5%
65+	19.8%	20.6%
Total	100%	100%

Source: Statistics Netherlands, LISA, BOM, Province of Brabant

2. ECONOMY

GDP* 2019 (in millions of euros, market prices)
Brabant 120,869 (14.9%)
The Netherlands 810,247 (100%)

Economic growth, 2020
Brabant -2.7%
The Netherlands -3.7%

Total own R&D spend as a percentage of GDP, 2019
Brabant 3.0%
The Netherlands 2.0%

Companies, 2020
Brabant 256,580 (14.3%)
The Netherlands 1,787,270 (100%)

Jobs, 2020
Brabant 1,341,750 (14.9%)
The Netherlands 8,983,430 (100%)

Foreign companies, 2020
Number of companies in Brabant 1,780
Brabant workforce 135,340

Industrial property
Total available in January 2020 (ha) 1,260
Immediately available in January 2020 (ha) 713

3. SECTOR OVERVIEW

A. Definition of the IT & Data Science sector

This study is based on the definition for the IT & Data Science priority sector, as outlined by Statistics Netherlands.

Hardware
2611 Manufacture of electronic components
2612 Manufacture of electronic circuit boards
2620 Manufacture of computers and peripheral equipment
2630 Manufacture of communication equipment
2640 Manufacture of consumer electronics
2651 Manufacture of measuring, control, navigation and control app.
2652 Manufacture of watch movements
2670 Manufacture of optical instruments and equipment
2680 Manufacture of information media
4651 Wholesale of computers, peripheral equipment and software
4652 Wholesale of electronic and telecommunications equipment

Telecommunication
6110 Wired telecommunication
6120 Wireless telecommunication
6130 Telecommunication by satellite
6190 Other telecommunications

Repair services
9511 Repair of computers and peripheral equipment
9512 Repair of communication equipment

Software and IT Services
5821 Publishing of computer games
5829 Other software publishing
6201 Developing, producing and publishing software
6202 Information technology consultancy
6203 Management of computer facilities
6209 Other service activities in the field of information technology
6311 Data processing, web hosting and related activities
6312 Web Portals

Figure 3: Definition of the IT & Data Science industry

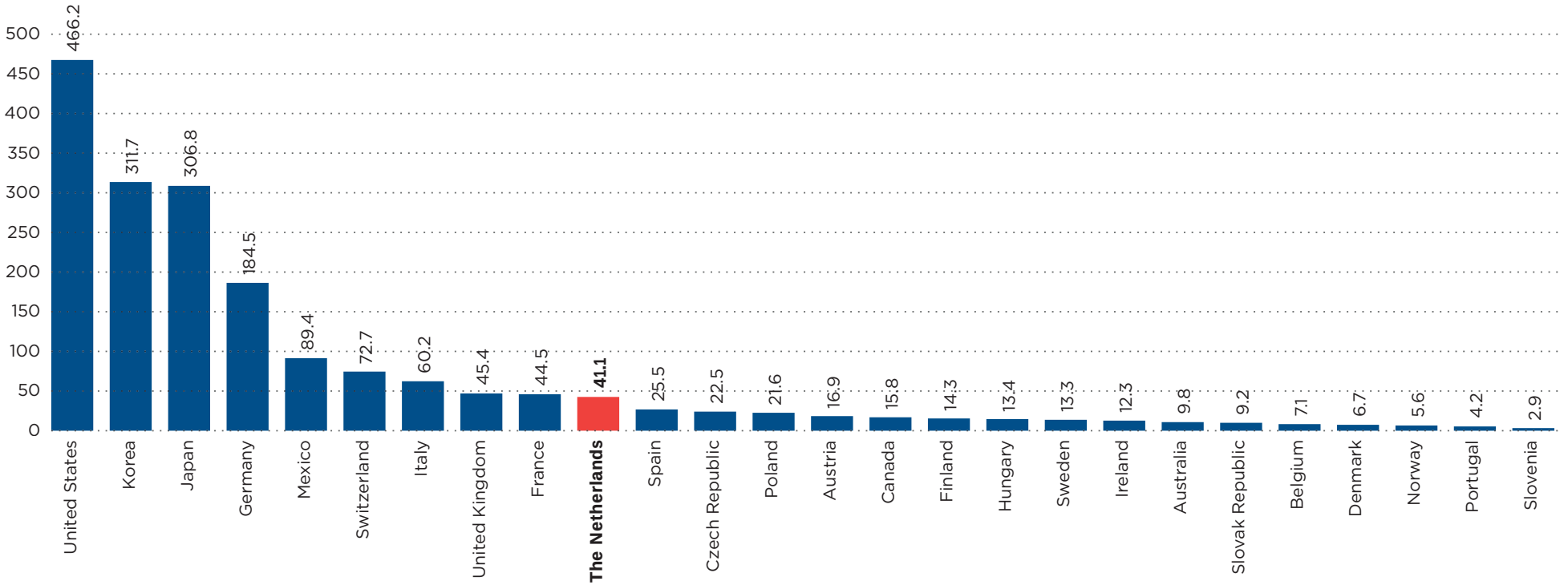
B. The Dutch IT sector from an international perspective

In 2019, the Dutch IT sector consisted of 79,350 companies employing 353,560 people, many of them working in innovative small and medium-sized enterprises (SMEs), startups, and scaleups. Together, these businesses generated 41.1 billion euros in production value and 18 billion US dollars in exports.

1. Production value of IT in 2015 (in billions of euros)

The Netherlands ranked tenth among the OECD countries[1] in the manufacture of IT goods and services. In Europe, it is the sixth largest manufacturer, after Germany, Switzerland, Italy, the United Kingdom, and France.

PRODUCTION VALUE OF THE IT & DATA SCIENCE SECTOR COUNTRIES, OECD

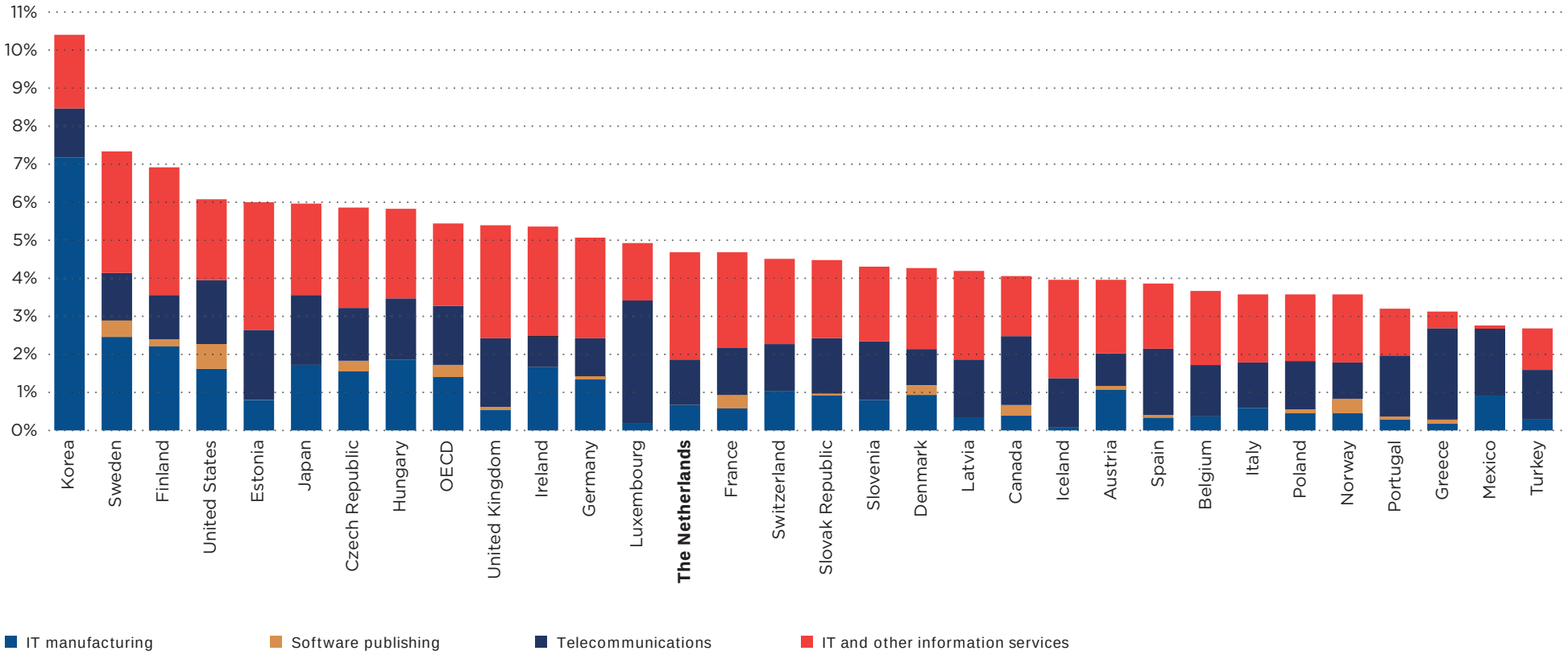


1 OECD is the Organization for Economic Cooperation and Development, in which 37 countries cooperate economically.

2. Value added by the IT sector and subindustries within the OECD countries

In total, the Netherlands is in the 14th place when it comes to the value added by the IT sector within the OECD countries as a percentage of the total value added at current prices. Within Europe, it is in tenth place. Unfortunately no data were available for the Dutch software publishing subsector.

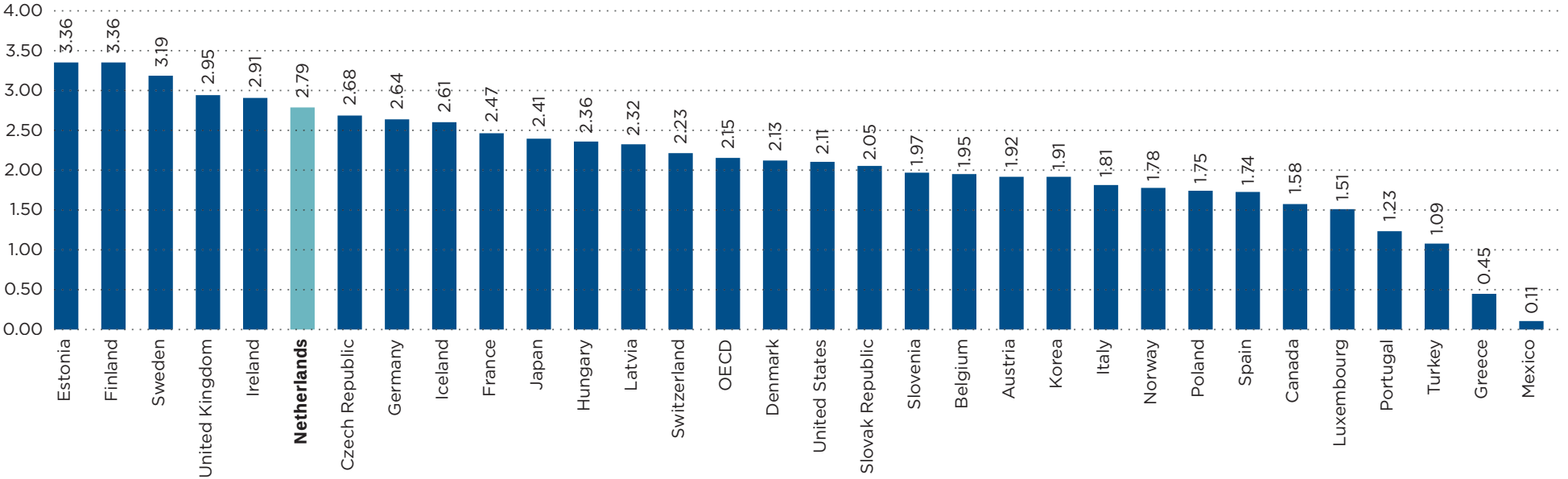
VALUE ADDED BY THE IT SECTOR AND SUBINDUSTRIES IN THE OECD COUNTRIES



Source: STAN: OECD Structural Analysis Statistics (database), ISIC Rev. 4, http://oe.cd/stan (accessed July 2017).

The greatest value is added by the IT and other information services within the Dutch subindustry. In the field of IT, the Netherlands is among the top six among OECD countries in terms of the value added by the IT and other information services subindustry.

VALUE ADDED SUB-INDUSTRY IT AND OTHER INFORMATION SERVICES



Graph 4: Value added in OECD Countries by the IT and other information services subindustry

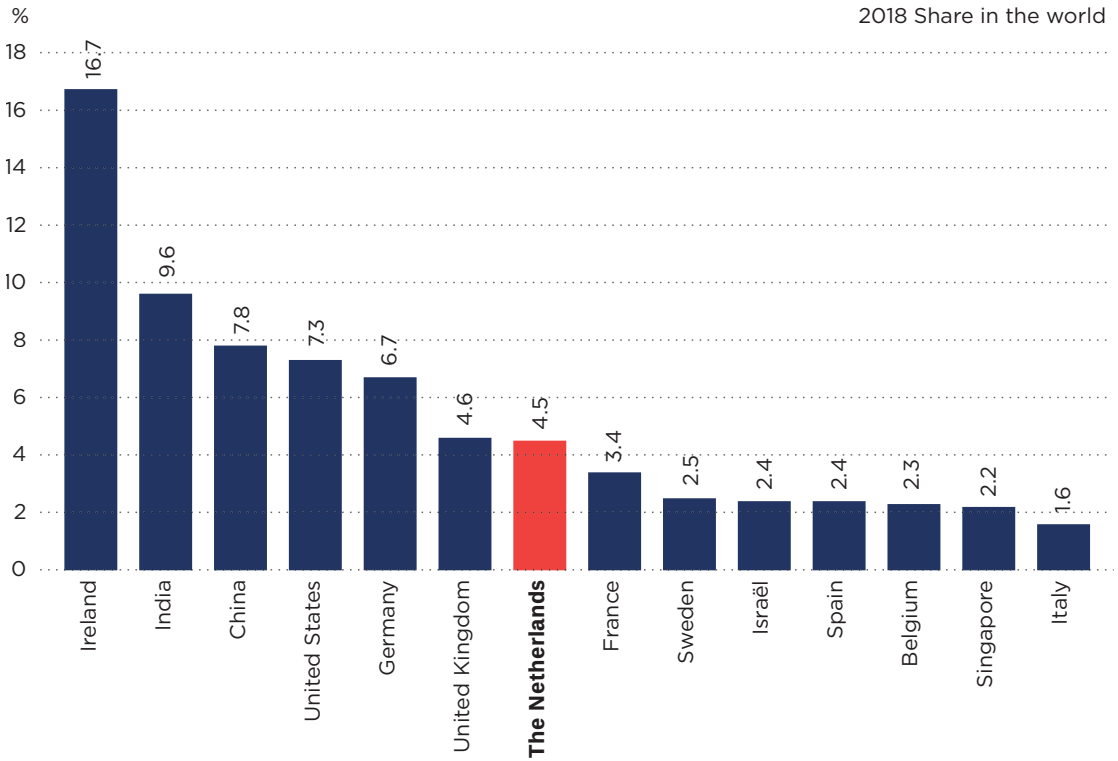
Source: STAN: OECD Structural Analysis Statistics (database), ISIC Rev. 4, http://oe.cd/stan (accessed July 2017).

3. Value of ICT imports and exports

In 2018, the Dutch import value of ICT goods and Services was 61.2 billion euros. This 1 percent less than in 2017. The import value of ICT goods and services amounted 61.8 billion euros. This is 10,6 % of the total Dutch import value.

In 2018, the export value of ICT-related goods and services (including re-exports) stood at 74.6 billion euros, 1.1 percent less than in the previous year (75.4 billion euros).

A. IMPORESIVE SHARE EXPORT VALUE OF IT SERVICES WORLDWIDE 2018 BY THE NETHERLANDS:



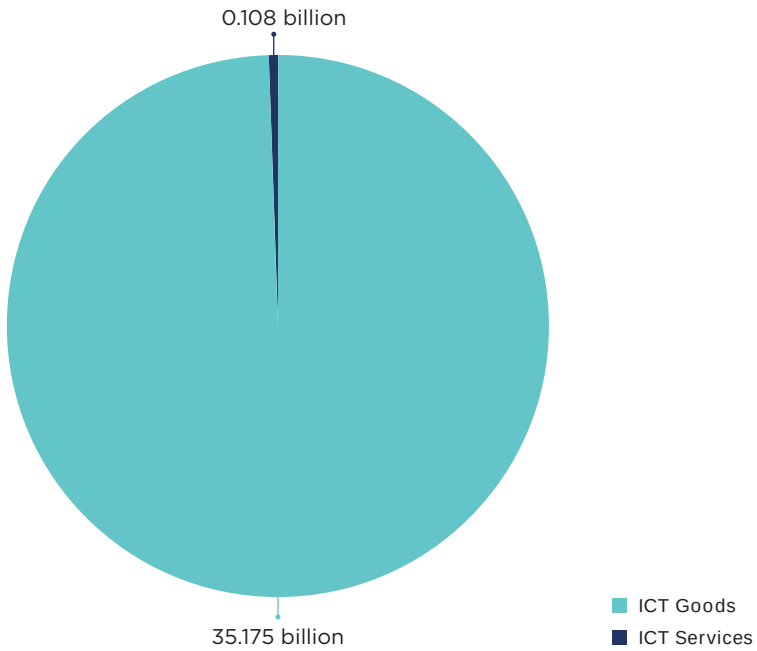
Source: UNCTAD

B. SHARE OF RE-EXPORTS IN IT EXPORTS IS RISING

Nearly half of all Dutch ICT exports in 2018 were re-exports. The total re-export value of the Netherlands was: 35.3 billion euros which is 47.3 percent of the total export value.

Re-exports concern ICT goods or services destined for use or consumption abroad. The Netherlands shows an steady and growing value in Re-Export.

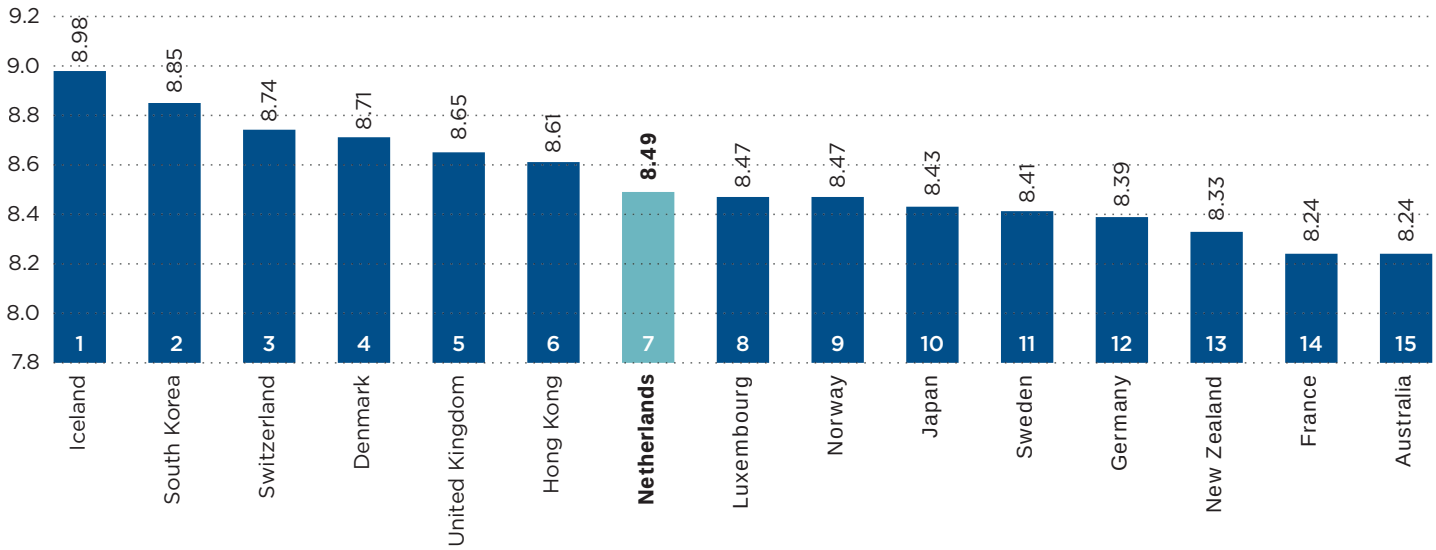
RE-EXPORT:



4. 2017 IT Development Index

The IT Development Index (IDI) is a composite index that combines 11 indicators into one benchmark measure. It is used to monitor and compare developments in information and communication technology (IT) between countries and over time. The following three elements are measured: IT readiness (infrastructure, access), IT use (intensity), and IT skills (capabilities). The Netherlands is the seventh most developed IT country in the world in terms of IT readiness (infrastructure, access), IT use (intensity) and IT skills (capabilities), according to the UN's International Telecommunication Union. Within Europe, the Netherlands is in fourth place.

IT DEVELOPMENT INDEX



Source: ITU (United Nations International Telecommunication Union), 2018, edited by Fanion Onderzoek & Advies

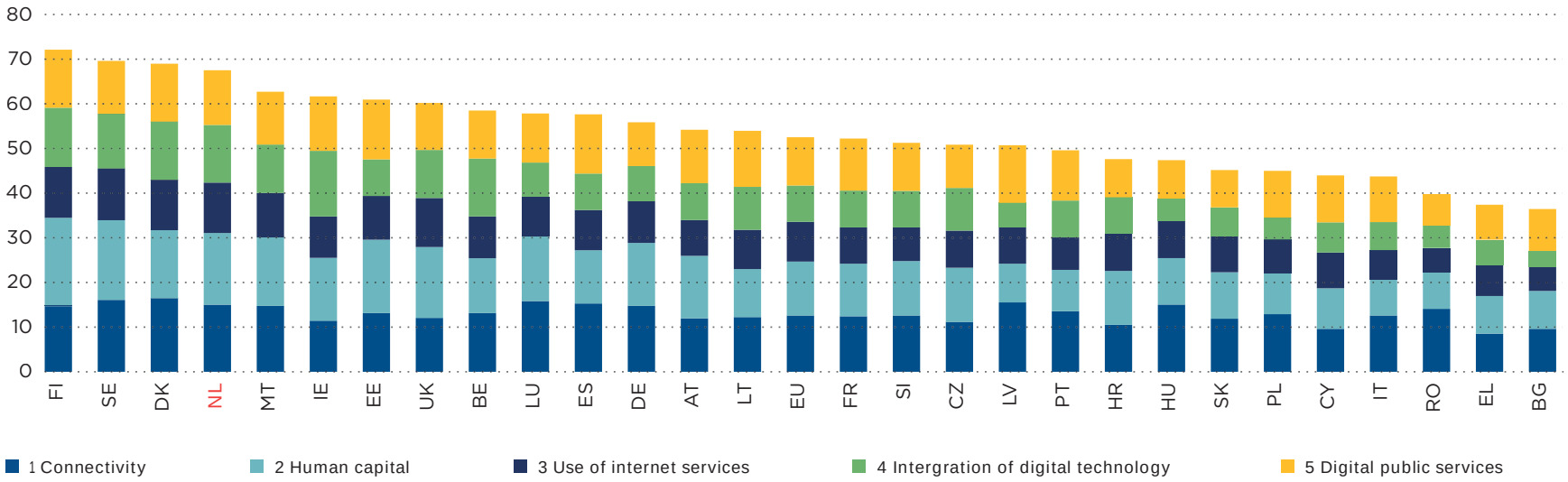
5. The Digital Economy and Society Index (DESI)

In 2015 the European Commission started monitoring member states' digital competitiveness using Digital Economy and Society Index (DESI) reports.

The Netherlands ranked fourth out of the 28 member states in the European Commission's 2020 Digital Economy and Society Index (DESI). According to the data of the European Commission, Finland, Sweden, Denmark, and the Netherlands have the most advanced digital economies in the EU, followed by Malta, Ireland, and Estonia.

The Netherlands remains one of the top performers across Europe, with solid and steady "digital growth". The country's scores for human capital, use of internet services, integration of digital technology, and digital public services all went upwards in 2020, in line with a comparable average increase across the EU.
The Netherlands is also among the top performers in respect of connectivity, with near-complete fast broadband coverage (next generation access/NGA) and 4G coverage. Meanwhile, 5G pilot projects have started in all regions of the Netherlands and testing licenses at a national level were already granted in 2017.
The mid-2019 review and update of the Dutch Digitalization Strategy, first adopted in 2018, confirmed the clear political commitment to take action and reap the benefits of the digital transformation. The accompanying strategies in key areas such as lifelong learning, artificial intelligence, and digitization of businesses are demonstrably based on a transparent and accountable approach in order to maximize the buy-in of all stakeholders.

2020 DIGITAL ECONOMY AND SOCIETY INDEX (DESI) RANKINGS:

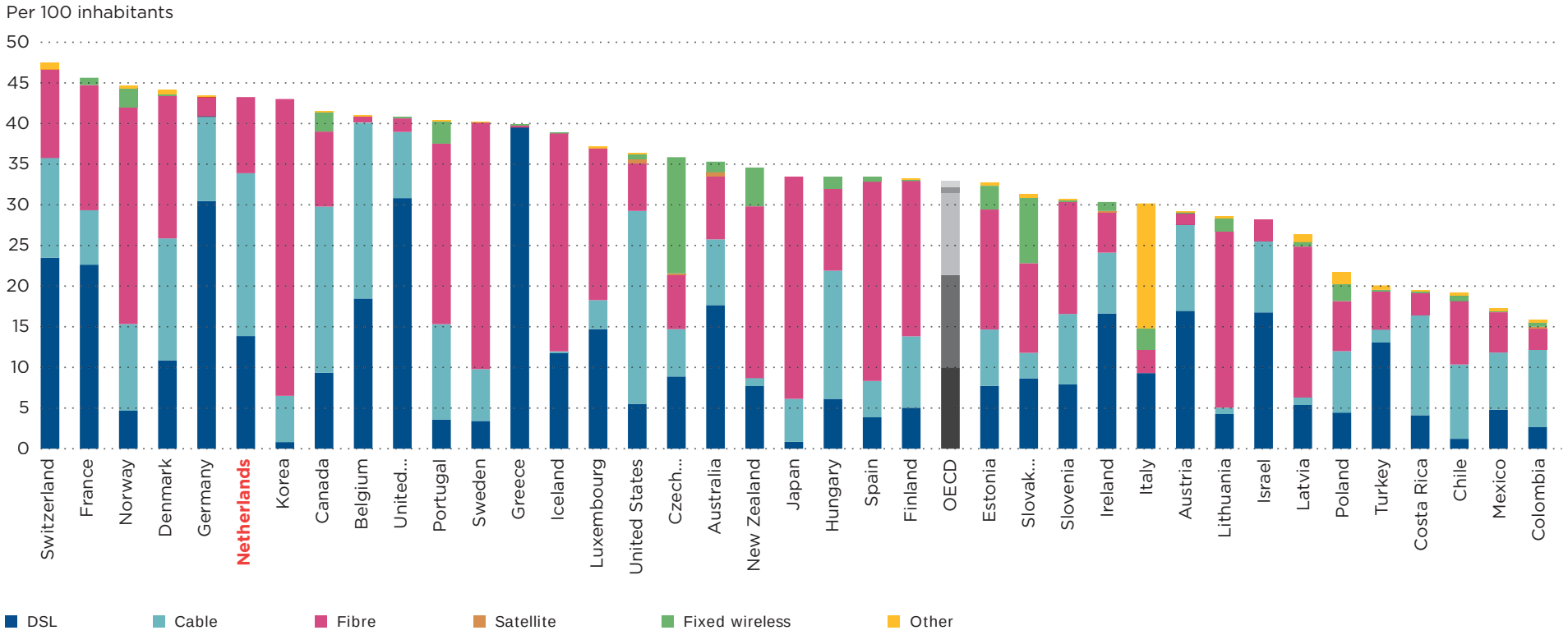


Source: European Commission, 2020 Digital Economy and Society Index (DESI)

6. Broadband penetration

The Netherlands is a world-leader in telecommunications. Broadband penetration has increased spectacularly in recent years, reaching 43%. and in 2020 the Netherlands ranked in sixth place.

FIXED BROADBAND SUBSCRIPTIONS PER 100 INHABITANTS, 2020

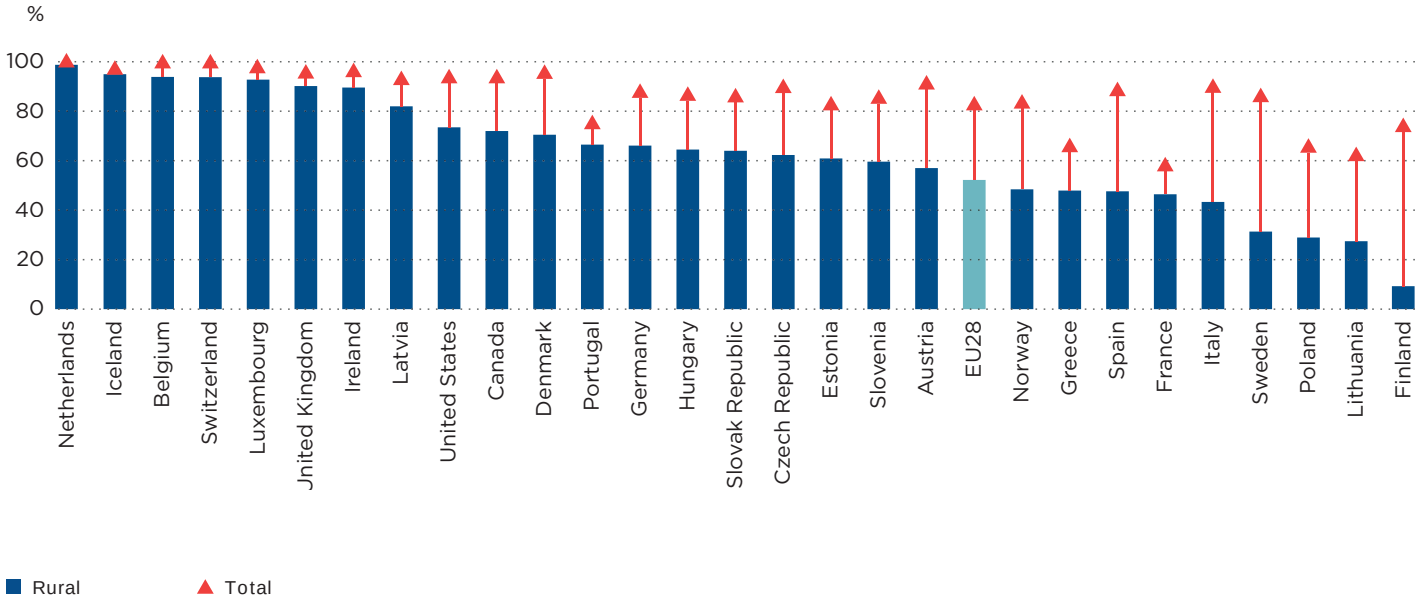


In addition, stiff competition has resulted in very competitively priced telephonic services in the Netherlands. Internet penetration is also one of the highest in the world, with 98% of the Dutch population having access to internet, and with 4G coverage for 99.3% of the country.

Source: OECD, Broadband Portal, 2020, edited by Fanion Onderzoek & Advies

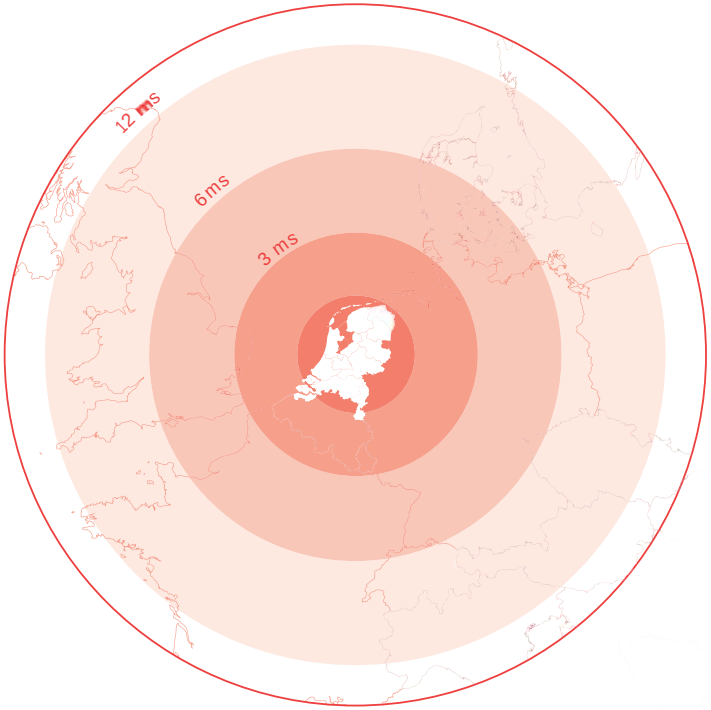
From the perspective of overall speed and broadband quality, the Netherlands takes first place in the EU. In total, nearly every household (99.8%) has access to a minimum of 30 Mbps of fixed broadband coverage. In addition, 99.6% of the households in the Netherlands have LTE mobile coverage. The country also remains the European leader when it comes to the number of homes with broadband speeds in excess of 50 Mbps.

HOUSEHOLDS WITH AT LEAST 30 MBPS OF FIXED BROADBAND COVERAGE, 2018:

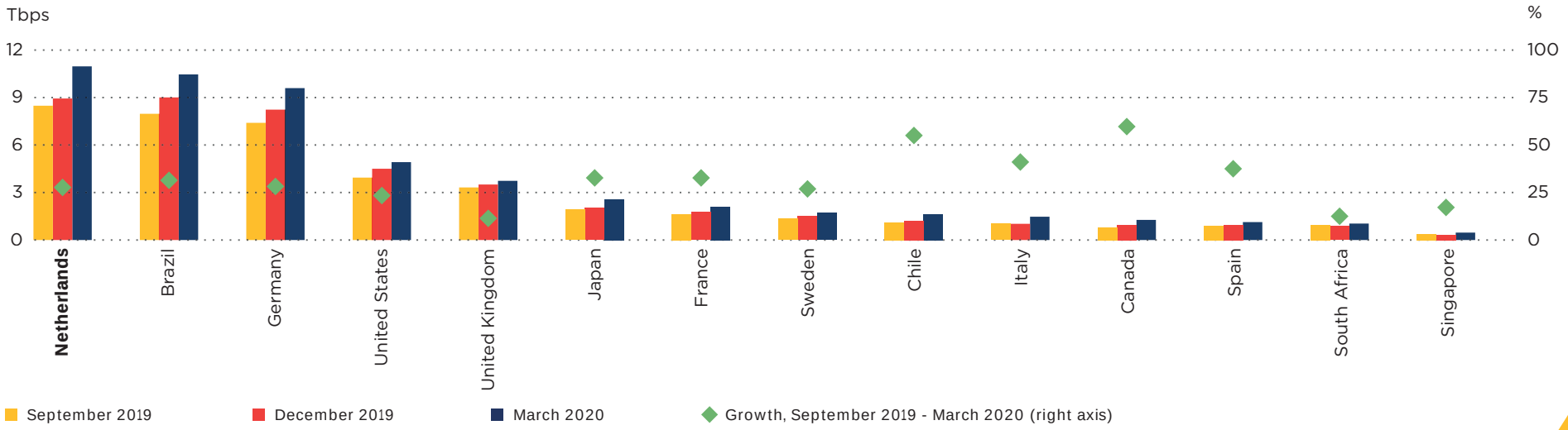


Source: OECD calculations, based on CRTC (2019), the 2019 Communications Monitoring Report (Canada), the European Commission (2019), Study on Broadband Coverage in Europe, 2018 (European Union), and the FCC (2019) 2019 Broadband Deployment Report (United States).

The Netherlands is the digital gateway to Europe. The Netherlands has the lowest average latency in Europe. With multiple submarine cable connections (a hub of intercontinental connections), the world's largest internet exchange (AMS-IX), a fully digital and advanced fiber-optic network, the highest broad-band connections in the European Union, and a large number of datacenters (over 200).



BANDWIDTH PRODUCED AT INTERNET EXCHANGE POINTS, 2020



C. BRABANT'S IT & DATA SCIENCE SECTOR

In 2019, Brabant's IT & Data Science sector consisted of 10,490 companies and a total of 42,630 jobs. Brabant has a share of 13.2% of the total number of IT businesses and 12.1% of the jobs in the Netherlands. To put this into perspective, while 14.7% of the Dutch population lives in Brabant, 15% of IT jobs and companies are found in the province, which means that IT is not as well-represented as one would expect, based on its share of the national economy.

It must however be noted that much of the IT strength in Brabant is derived from companies engaged in a different principal activity. **A high proportion of IT staff in Brabant work in other industries, such as High-tech Systems and Maintenance (HTMS), Life Sciences & Health, or Logistics**. Research conducted by pr-eDICT, the center of expertise for digitalization and IT, shows that in 2019 a total of around **79,000 IT professionals were working in Brabant.** 51.6% of these 79,000 IT professionals are working outside the IT & Data Science Sector. This means that more than 40,500 IT professionals in Brabant are working outside the IT & Data Science sector.

COMPANIES IN PRIORITY INDUSTRIES IN BRABANT

	Brabant	Netherlands	Share of Brabant in NL
Priority industry	**Companies**	**Companies**	**Companies**
HTSM	15,480	96,330	16.1%
AgriFood	14,060	89,090	15.8%
Life Sciences & Health	530	3,640	14.5%
Logistics and warehousing	5,920	46,500	12.7%

Source: Brabant Register of Establishments and LISA, 2019

1. Brabant as part of the Netherlands

COMPANIES AND JOBS IN BRABANT AND THE NETHERLANDS IN THE IT SECTOR, 2019

IT		
	Number of companies	Number of jobs
Brabant	10,490	42,630
The Netherlands	79,350	353,560
Brabant's share	13.2%	12.1%

We identify four subindustries of IT in this study: hardware, software and IT services, telecommunications, and repair services.
Most jobs in Brabant's IT sector can be found in the software and IT services, with 67.7% of the jobs, followed by the hardware with 28.5%. Telecommunications accounts for 2.8% of the jobs and repair services for only 1.1%.

The Eindhoven/Helmond region (southeast Brabant) is home to the largest IT industry by a wide margin, with 3,812 companies and 17,050 jobs, followed by the Den Bosch region with 2,366 companies or branches and 12,050 jobs, and Breda region with 2,557 businesses and 8,580 jobs.

The composition of the IT sector also differs per region. The hardware subindustry is well-represented in the Eindhoven/Helmond region and Tilburg (central Brabant). Software and IT services is the largest subindustry in all regions but has a relatively strong presence in the Den Bosch region (northeast Brabant). Telecommunications is also well-represented in the Den Bosch region.

The repair services subindustry is by far the smallest part of the sector in every region, with the majority of the subindustry's presence being in the Tilburg region.

Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

2. Number of IT & Data Science jobs by subregion, subindustry, and branch

NUMBER OF IT & DATA SCIENCE JOBS BY SUBREGION, SUBINDUSTRY, AND BRANCH

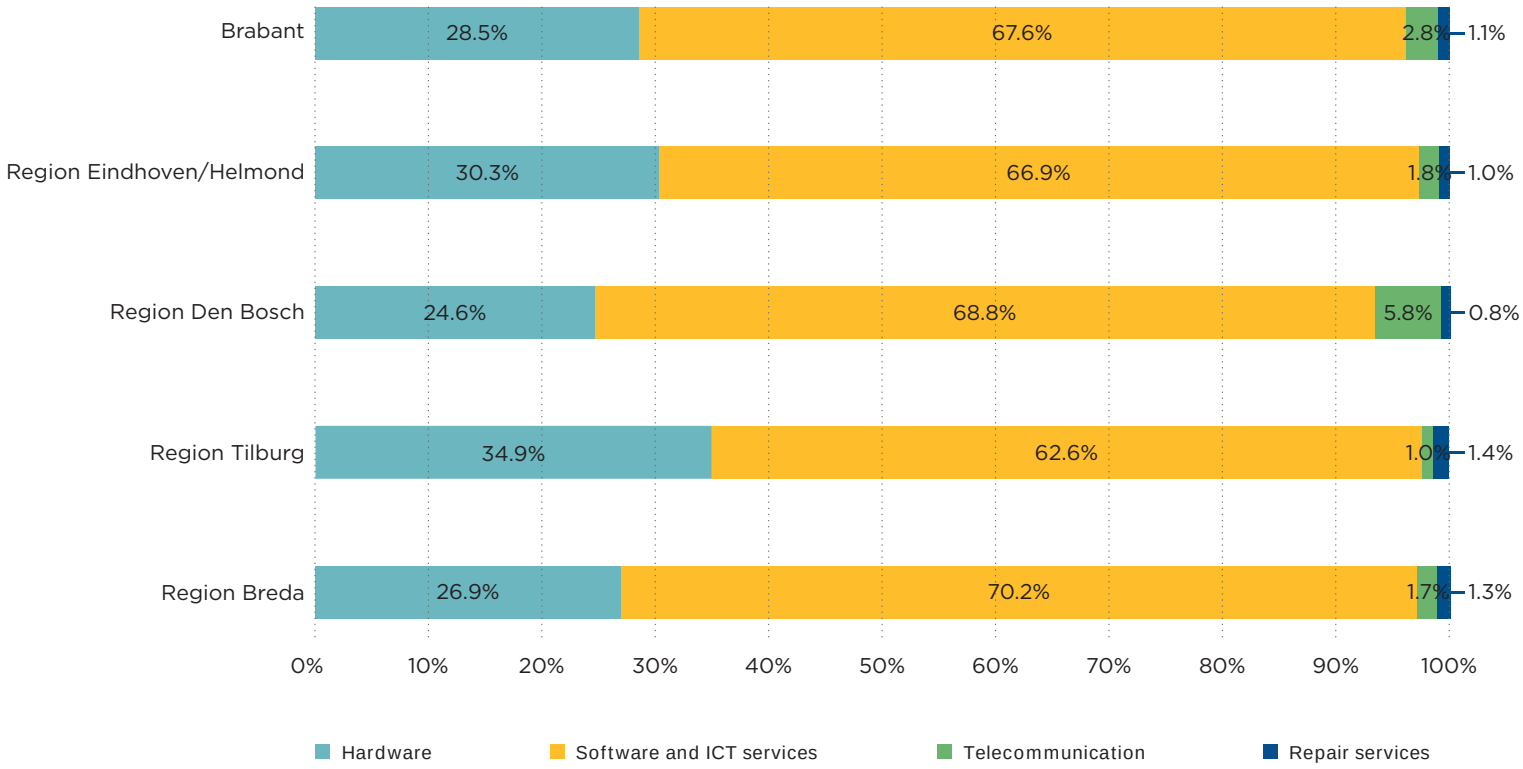
	Software and IT			Repair	
	Hardware	Services	Telecommunications	Services	Total IT jobs
Breda region	2,310	6,020	150	110	8,580
Tilburg region	1,730	3,100	50	70	4,950
Den Bosch region	2,960	8,290	700	100	12,050
Eindhoven/Helmond region	5,170	11,400	310	170	17,050
Brabant	**12,170**	**28,810**	**1,210**	**450**	**42,630**

COMPANIES AND JOBS IN BRABANT AND THE NETHERLANDS IN THE IT SECTOR, 2019

	Software and IT			Repair	
	Hardware	Services	Telecommunications	Services	Total IT
Breda region	297	2,138	28	94	2,557
Tilburg region	171	1,508	15	63	1,757
Den Bosch region	265	2,016	19	66	2,366
Eindhoven/Helmond region	484	3,202	41	85	3,812
Brabant	**1,217**	**8,864**	**103**	**308**	**10,492**

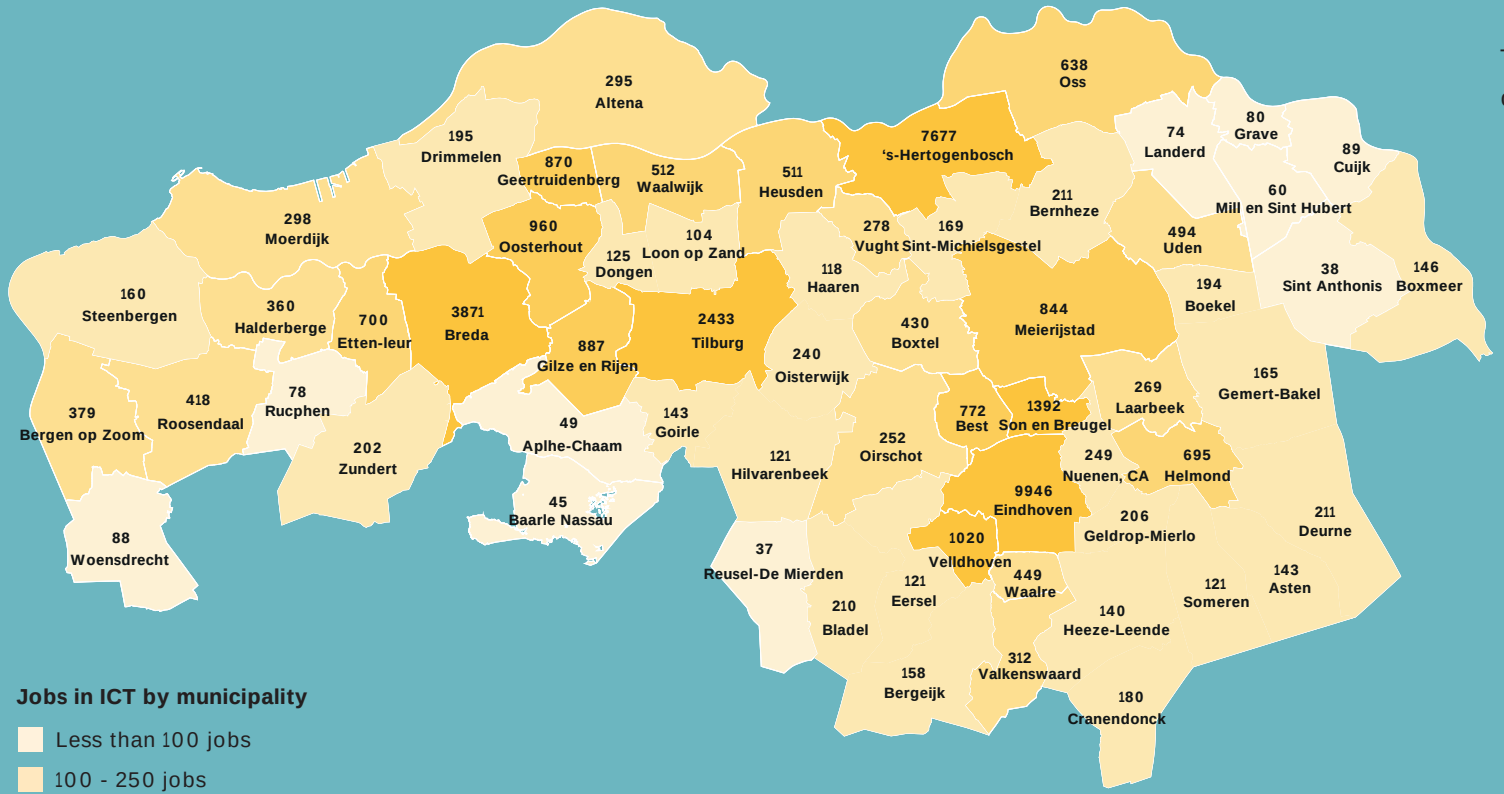
Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

IT & DATA SCIENCE SUBINDUSTRY EMPLOYMENT, IN BRABANT AS A WHOLE AND IN THE SUBREGIONS



Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

NUMBER OF IT JOBS BY MUNICIPALITY



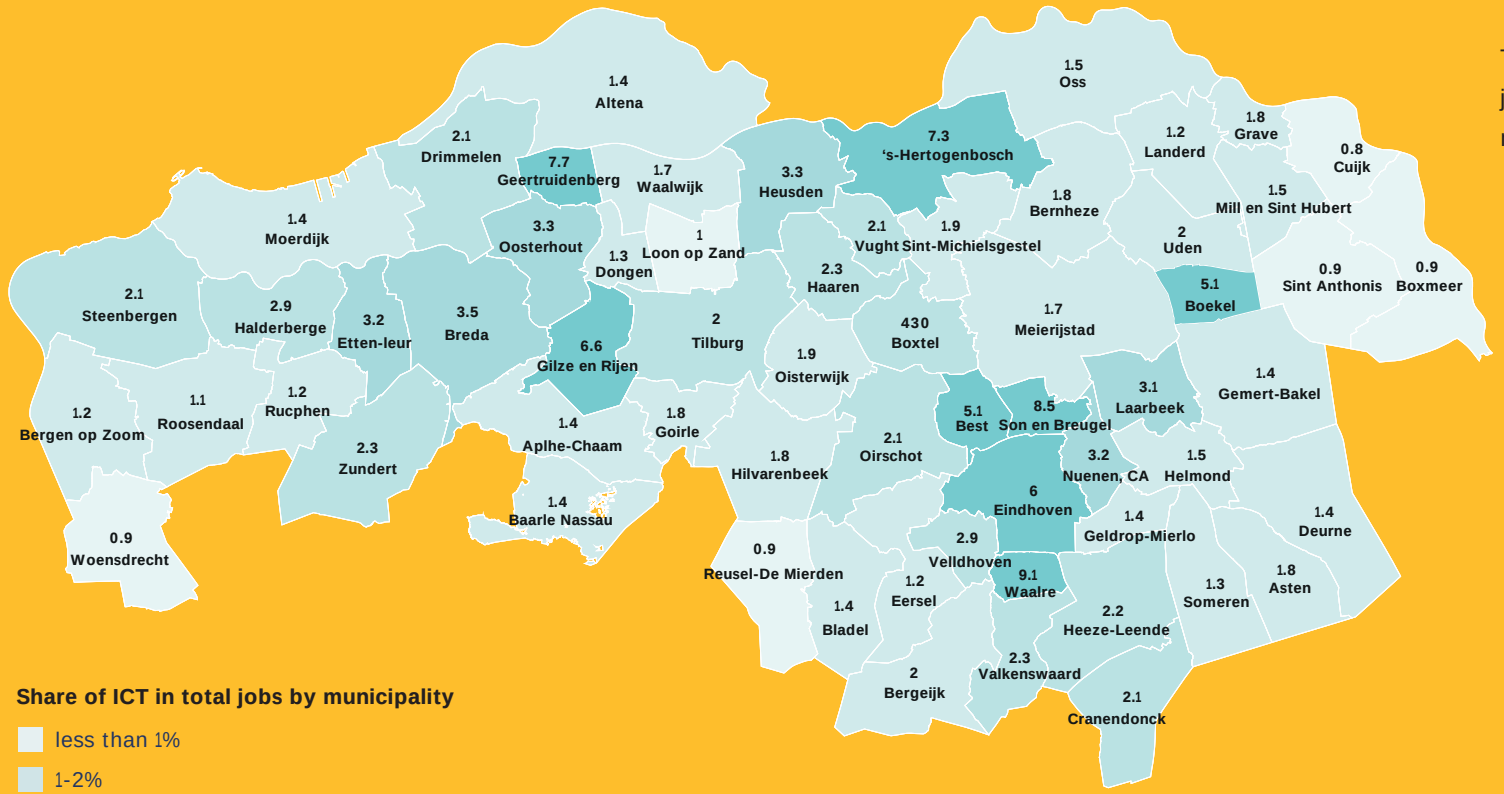
The map below shows the total number of jobs in the IT sector per municipality.

Jobs in ICT by municipality

- Less than 100 jobs
- 100 - 250 jobs
- 250 - 500 jobs
- 500 - 750 jobs
- 750 - 1.000 jobs
- More than 1.000 jobs

Source: Brabant Register of Establishments, 2019, QGIS, edited by Fanion Onderzoek & Advies

SHARE OF IT JOBS BY MUNICIPALITY



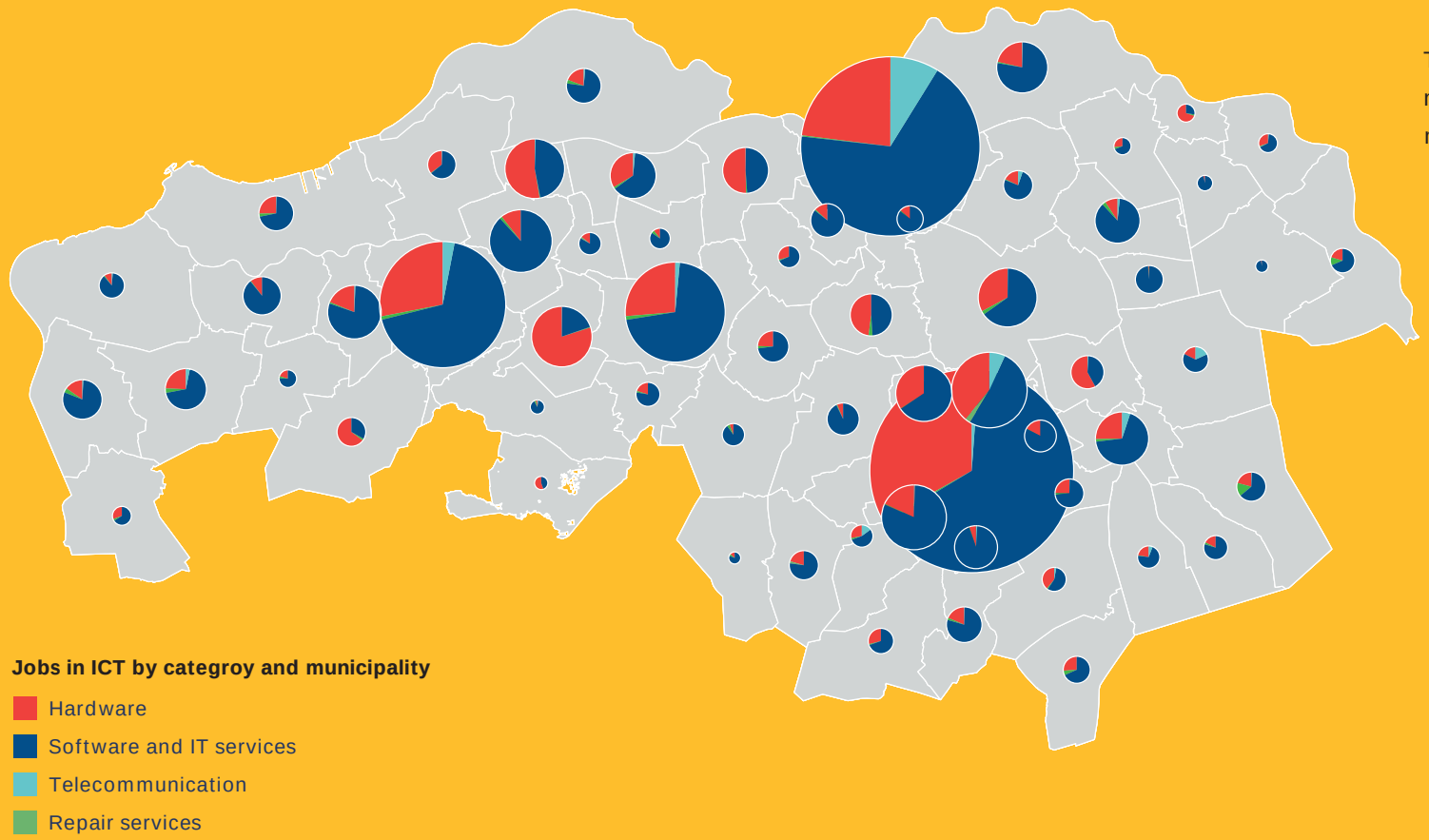
Share of ICT in total jobs by municipality

- less than 1%
- 1-2%
- 2-3%
- 3-4%
- 4-6%
- More than 5%

The map below shows the number of jobs in IT as a proportion of the total number of jobs in each municipality.

Source: Brabant Register of Establishments, 2019, QGIS, edited by Fanion Onderzoek & Advies

IT EMPLOYMENT HOTSPOTS BY MUNICIPALITY



Jobs in ICT by categroy and municipality

- Hardware
- Software and IT services
- Telecommunication
- Repair services

The map below plots the proportional number of jobs in IT by subindustry and municipality.

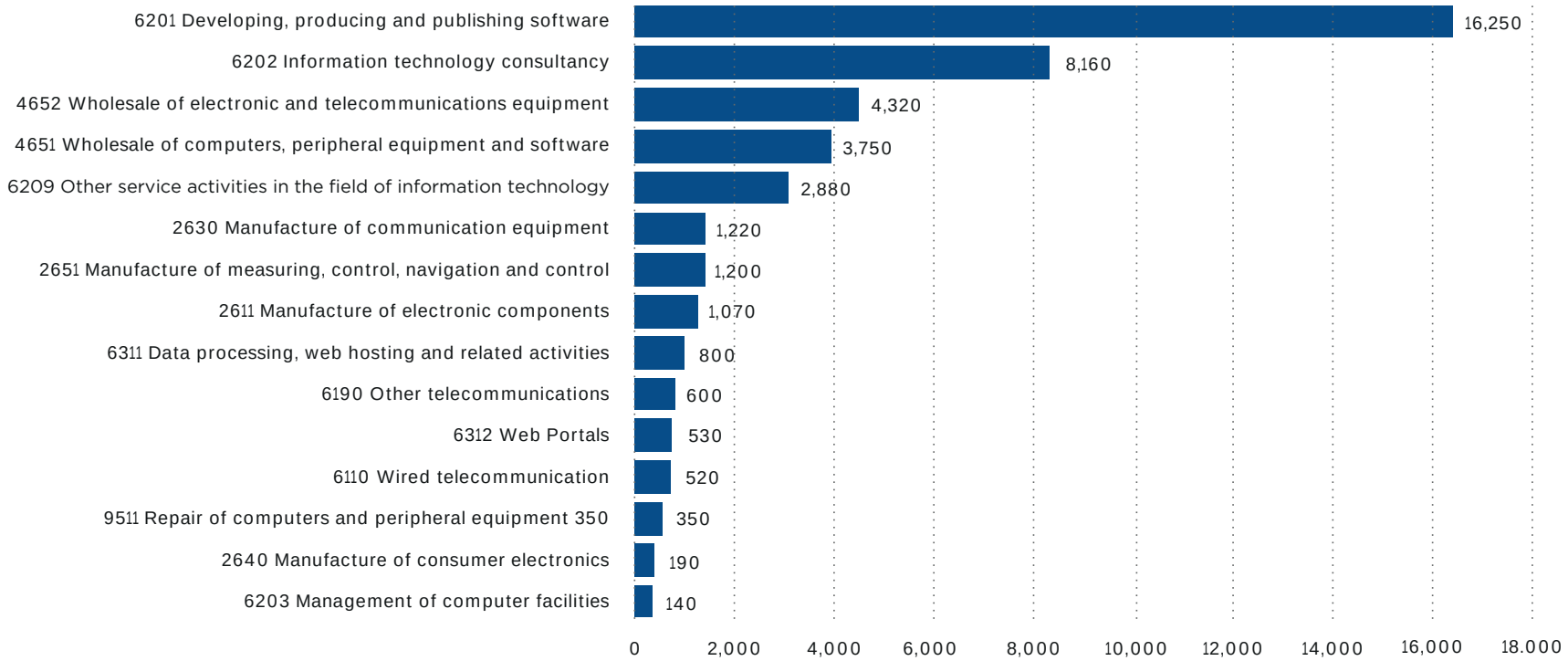
Source: Brabant Register of Establishments, 2019, QGIS, edited by Fanion Onderzoek & Advies

In terms of jobs, the largest branches in the IT sector are related to developing, producing, and publishing software (16,250 jobs), information technology consultancy (8,160 jobs), wholesale of electronic and telecommunications equipment (4,320 jobs), wholesale of computers, peripheral equipment and software (3,750 jobs) and other service activities in the field of information technology (2,880 jobs).

In general, the industry is responsible for 15% of the total number of jobs in Brabant, while the province's stake of IT jobs in the Netherlands as a whole is slightly lower, at 13%.

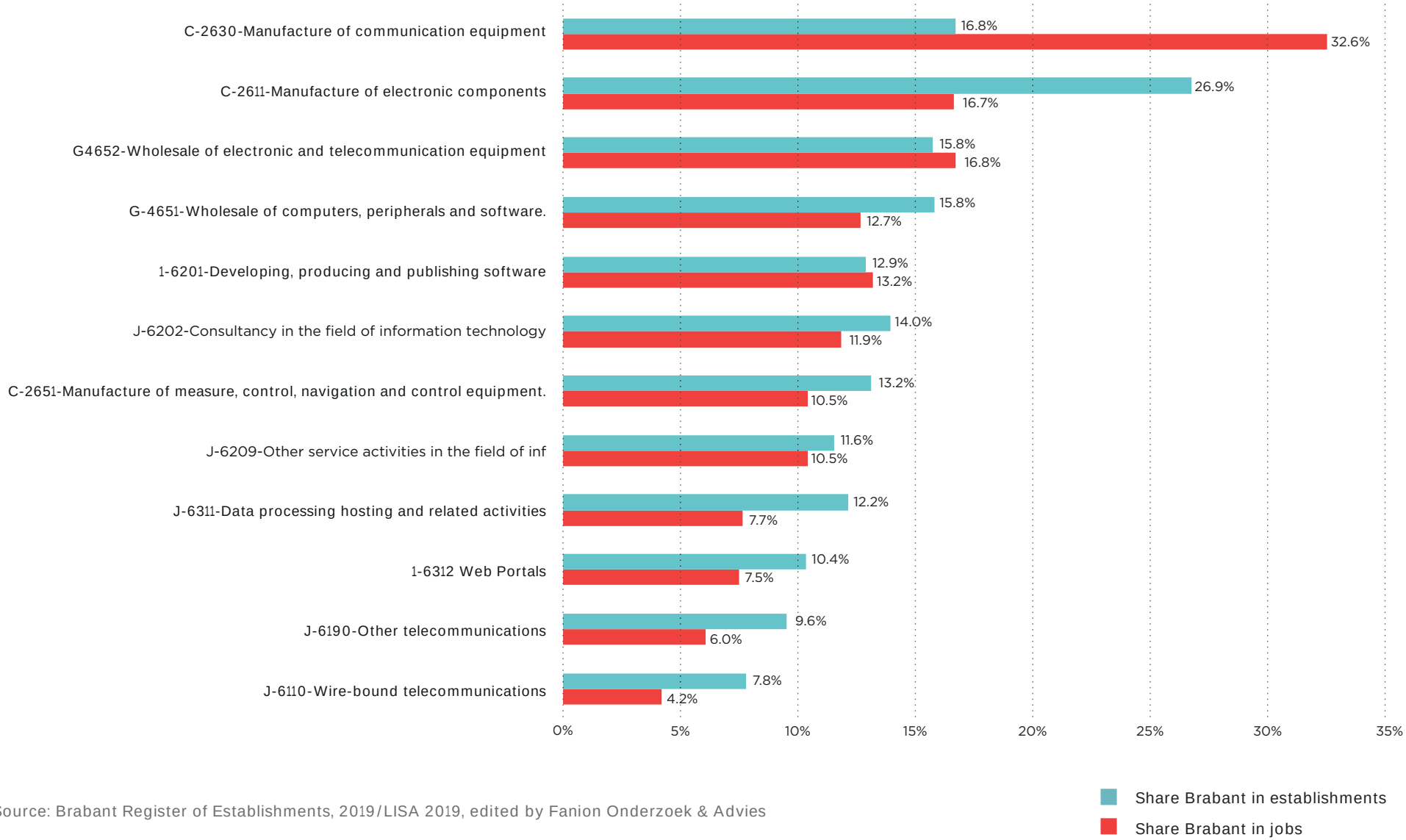
When compared to the composition of the IT sector in the Netherlands as a whole, the following branches are represented at an above average rate in Brabant, with a share in excess of 15%: manufacture of communication equipment (32.6%), manufacture of electronic components (16.7%) and wholesale of electronic and telecommunication equipment (16.8%).

LARGEST IT BRANCHES IN BRABANT, NUMBER OF JOBS, 2019



Source: Brabant Register of Establishments, 2019/LISA 2019, edited by Fanion Onderzoek & Advies

IT BRANCHES WHERE BRABANT HAS THE LARGEST NUMBER OF JOBS IN THE NETHERLANDS (AT LEAST 500 OR MORE)



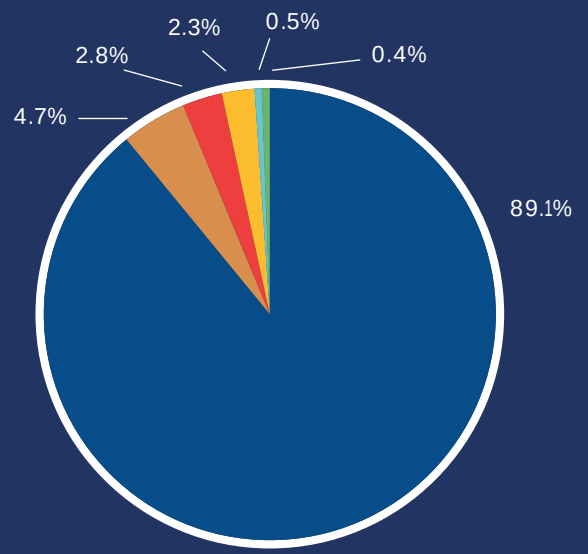
Source: Brabant Register of Establishments, 2019/LISA 2019, edited by Fanion Onderzoek & Advies

The IT sector is dominated by small firms, with 89.1% of businesses employing less than five people, 9.8% employing between five and fifty people, and only 1.1% of companies with a workforce of fifty or more staff.

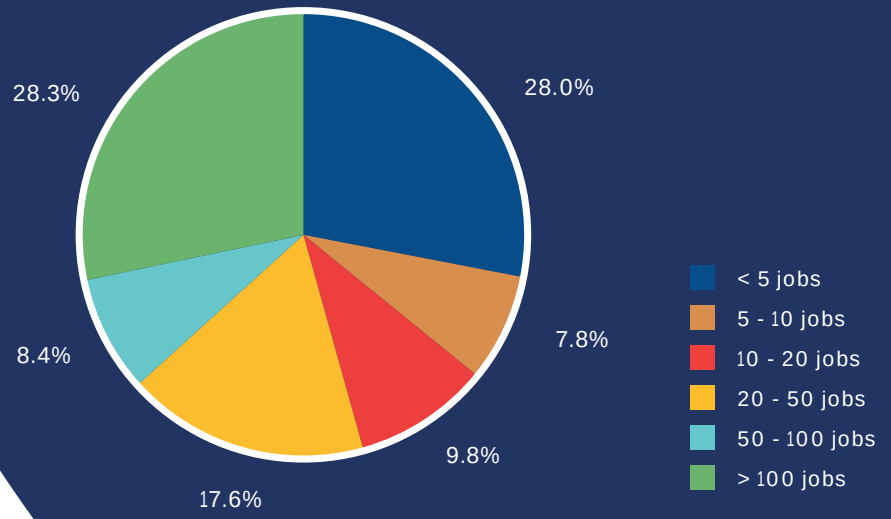
However, those companies with a staff complement of over a hundred employees account for 28% of the employment in the IT sector – the same figure as those small companies employing less than five people.

The repair services sector is made up almost entirely of small enterprises, with 98% employing less than five people. Large companies with over a hundred staff members tend to focus on developing and manufacturing hardware (2.1% of the companies and 37.5% of the jobs) and on telecommunications (1.9% of the companies and 46% of the jobs).

PERCENTAGE OF IT COMPANIES IN BRABANT BY COMPANY SIZE, 2019



EMPLOYMENT IN BRABANT BY IT COMPANIES, GROUPED ACCORDING TO COMPANY SIZE, 2019



Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

BRABANT IT COMPANIES AND SUBCATEGORIES, BY COMPANY SIZE, 2019

	Hardware	Software and IT services	Telecommunication	Repair services	IT
< 5 jobs	71.4%	91.4%	70.9%	98.1%	89.1%
5-10 jobs	10.8%	3.9%	10.7%	1.0%	4.7%
10-20 jobs	7.5%	2.2%	8.7%	0.3%	2.8%
20-50 jobs	6.4%	1.8%	4.9%	0.6%	2.3%
50-100 jobs	1.8%	0.3%	2.9%	0.0%	0.5%
> 100 jobs	2.1%	0.4%	1.9%	0.0%	0.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

BRABANT IT COMPANIES AND SUBCATEGORY EMPLOYMENT FIGURES, BY COMPANY SIZE, 2019

	Hardware	Software and IT services	Telecommunication	Repair services	IT
< 5 jobs	11.6%	34.9%	10.3%	78.2%	28.0%
5-10 jobs	7.5%	8.0%	6.7%	6.0%	7.8%
10-20 jobs	10.3%	9.7%	9.8%	2.7%	9.8%
20-50 jobs	20.4%	16.8%	11.3%	13.1%	17.6%
50-100 jobs	12.7%	6.4%	15.9%	0.0%	8.4%
> 100 jobs	37.5%	24.1%	46.0%	0.0%	28.3%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

3. The rise of HTSM companies and employment levels

COMPANIES

The number of Brabant IT companies has increased by 10.5%, from 9,496 in 2015 to 10,492 in 2019. In the Netherlands, the number of businesses grew even faster, by 15.5%.

At 14.6%, software and IT services were Brabant's fastest growers, while those subindustries grew even faster in the Netherlands at 19.4%. Companies focusing on hardware and telecommunications declined in number in both Brabant and the Netherlands, with hardware companies shrinking by 5.7% in Brabant and by 4.5% in the Netherlands, and an even greater declines for telecommunications businesses, down 38% in Brabant and 21.2% in the Netherlands.

EMPLOYMENT

In Brabant the number of IT jobs grew between 2015 and 2019 by 9.8%. This growth was not as strong as in the Netherlands overall (12.7%). Growth in Brabant's IT industry was strongest in software and IT services, with the number of jobs rising by 15.8% (compared to the Netherlands at 18.5%). Hardware-oriented jobs also rose in number (Brabant by 3.1% and the Netherlands by 6.1%). Telecommunications and repair services jobs shrunk between 2015 and 2019 (declining by 27.4% in Brabant and 10.5% in the Netherlands for the former and 6.8% in Brabant and 3% in the Netherlands for the latter).

When looked at in more detail, the subindustries with the biggest rise in jobs were: consultancy in the field of information technology (Brabant at 23.6%; Netherlands at 21%), web portals (Brabant at 20.1%; Netherlands at 5.4%), developing, producing and publishing software (Brabant at 18.7%; Netherlands at 17.3%), manufacture of measuring, control, navigation and control equipment (Brabant at 18.1%; Netherlands at 15.2%), and manufacture of communication equipment (Brabant at 11.4%; Netherlands with a decline of 1%).

The subindustries experiencing slow job growth or even a decline in employment are: wire-bound telecommunications (Brabant at -21.2%; Netherlands at 14.4%), other telecommunications (Brabant at -13.1%; Netherlands at 0.9%), wholesale of computers, peripherals and software (Brabant at -6.3%, Netherlands at 5.1%), data processing, hosting and related activities (Brabant at -1.2%; Netherlands at 32.1%), and wholesale of electronic and telecommunication equipment (Brabant at 4.0%; Netherlands at 2.3%)

GROWTH OF IT COMPANIES AND EMPLOYMENT IN BRABANT AND THE NETHERLANDS, 2015-2019

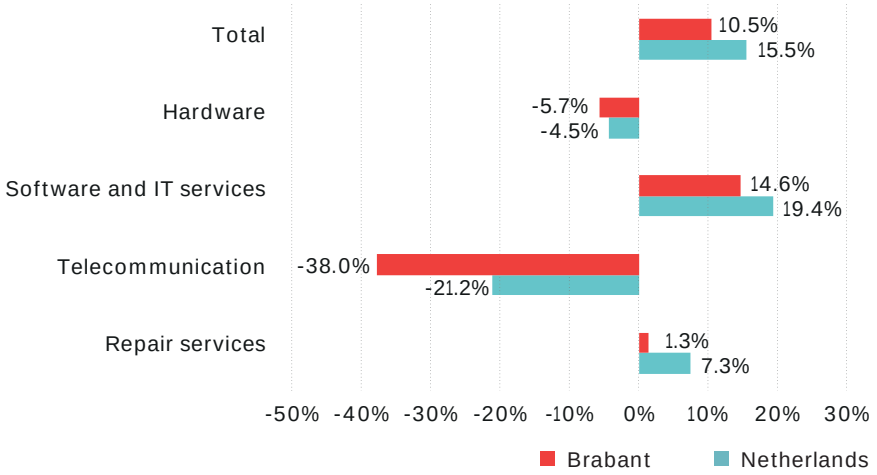
	Companies Brabant			Companies Netherlands		
(Sub)industry	**2015**	**2019**	**2015-2019**	**2015**	**2019**	**2015-2019**
Hardware	1,290	1,217	-5.7%	7,723	7,379	-4.5%
Software and IT services	7,736	8,864	14.6%	57,565	68,716	19.4%
Telecommunications	166	103	-38.0%	1,502	1,183	-21.2%
Repair services	304	308	1.3%	1,933	2,075	7.3%
Total	**9,496**	**10,492**	**10.5%**	**68,723**	**79,353**	**15.5%**

BRABANT IT COMPANIES AND SUBCATEGORY EMPLOYMENT FIGURES, BY COMPANY SIZE, 2019

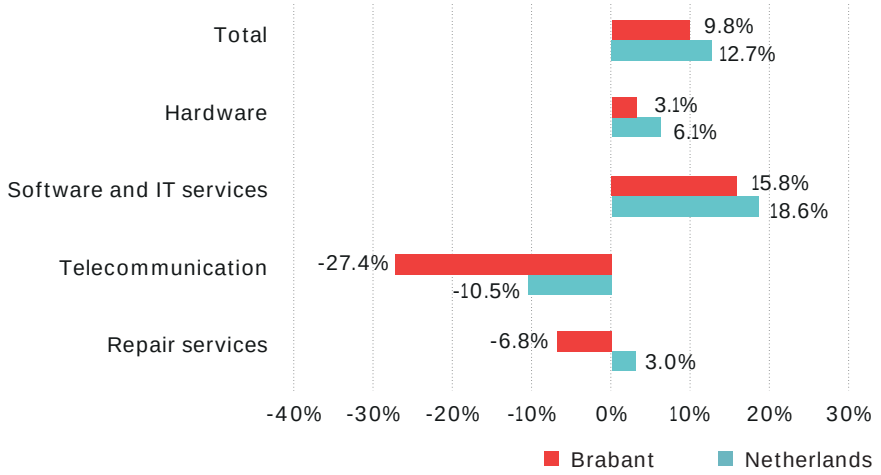
	Jobs Brabant			Jobs Netherlands		
(Sub)industry	**2015**	**2019**	**2015-2019**	**2015**	**2019**	**2015-2019**
Hardware	11,800	12,170	3.1%	76,600	81,310	6.1%
Software and IT services	24,870	28,810	15.8%	204,040	242,000	18.6%
Telecommunications	1,670	1,210	-27.4%	28,630	25,630	-10.5%
Repair services	480	450	-6.8%	4,490	4,630	3.0%
Total	**38,820**	**42,630**	**9.8%**	**313,760**	**353,560**	**12.7%**

Source: LISA, Brabant Register of Establishments, 2015-2019, edited by Fanion Onderzoek & Advies

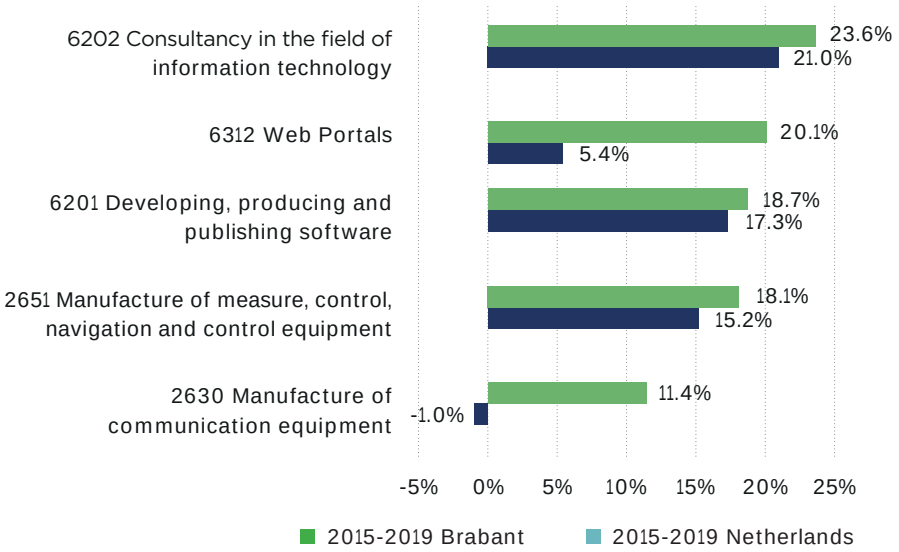
GROWTH OF COMPANIES IN BRABANT AND THE NETHERLANDS, 2015-2019



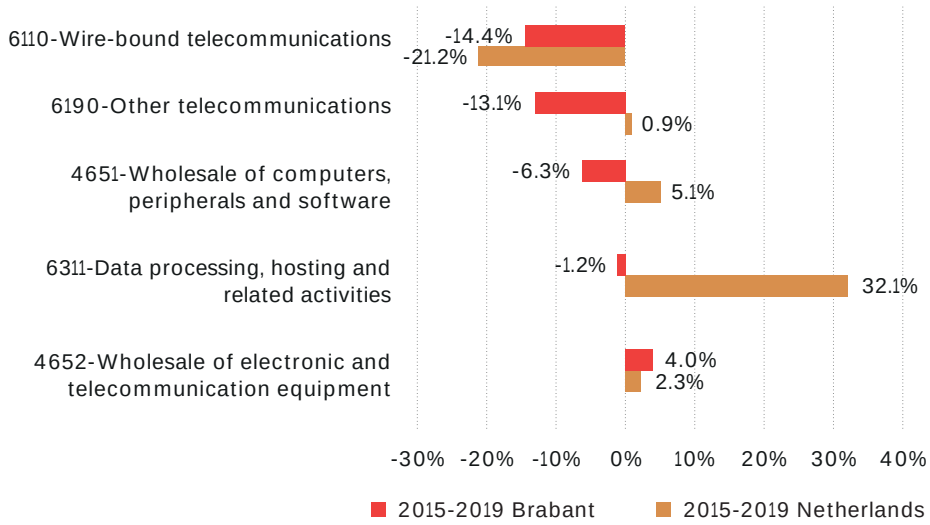
GROWTH IN EMPLOYMENT IN BRABANT AND THE NETHERLANDS, 2015-2019



TOP 5 BRANCHES* FOR EMPLOYMENT GROWTH IN BRABANT, 2015 - 2019



TOP 5 BRANCHES* WITH THE GREATEST DECLINE IN EMPLOYMENT IN BRABANT, 2015-2019



Source: LISA, Brabant Register of Establishments, 2015-2019, edited Fanion Onderzoek & Advies

* branches employing at least 500 people in Brabant

4. The regional distribution of IT activities in Brabant

In total, the IT sector comprises more than 42,500 jobs, representing almost 3.3% of all employment in Brabant. Jobs in IT are mainly clustered in the immediate vicinity of the province's largest cities, being Eindhoven, Den Bosch, Breda, and Tilburg. These cities are likewise home to the largest companies. Eindhoven accounts for the largest number of IT jobs, with 9,950 jobs. Major IT firms such as Atos, Sogeti, IT Group, Bosch Security Systems, Copaco, VHE Industrial Automation, Itelligence, and Sioux Embedded Systems are located in the city.

Den Bosch comes in second with a total of 7,680 jobs, and is home to large software development companies such as SAP, Dassault Systemes, PinkRoccade, and Siemens Industry Software, as well as hardware manufacturers such as Omron, Super Micro Computer, and KPN, the largest telecommunications provider in the Netherlands.

In Breda, large IT companies include SD Worx Nederland, Amadeus Hospitality, Grass Valley, Skalar Analytical, Axi, Datamex, and TrueLime. Tilburg counts among its companies Ingram Micro CFS, Vecozo, Aces Direct, LiveWall, Isah Business Solutions, Magneds.com, and Indicia. The cities with the largest share of the IT sector in terms of total number of jobs are Waalre (9.1% and home to Acknowledge, Dream Chip Technologies, and others), Son en Breugel (8.5% and the location of Neways Industrial Systems, Advantech, Signet, Zetes, and Centric), Geertruidenberg (7.7% and home to MyBrand and others), Den Bosch (7.3%), and Gilze en Rijen (6.6% and the location of Ericsson, Global-e IT solutions, Audax, Serticom, and others).

THE FIVE LEADING MUNICIPALITIES IN BRABANT IN TERMS OF TOTAL NUMBER OF IT JOBS, 2019

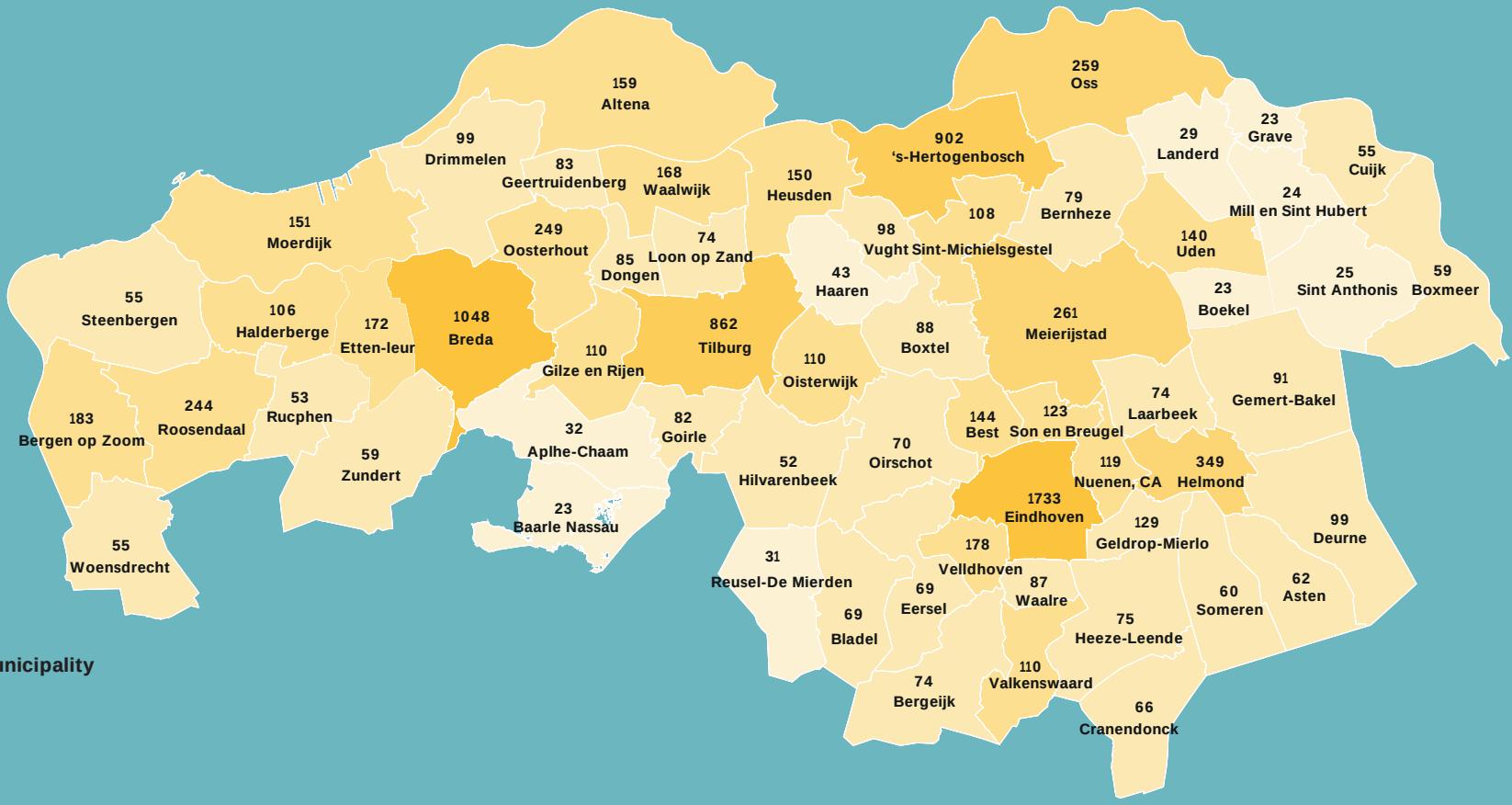
Municipality	Number of jobs
Eindhoven	9,950
Den Bosch	7,680
Breda	3,870
Tilburg	2,430
Son en Breugel	1,390

THE FIVE LEADING MUNICIPALITIES IN BRABANT IN TERMS OF IT JOBS AS A PROPORTION OF TOTAL EMPLOYMENT, 2019

Municipality	Percentage of IT jobs
Waalre	9.1%
Son en Breugel	8.5%
Geertruidenberg	7.7%
Den Bosch	7.3%
Gilze en Rijen	6.6%

Source: LISA, Brabant Register of Establishments, 2015, 2019, edited Fanion Onderzoek & Advies

NUMBER OF IT COMPANIES, BY MUNICIPALITY

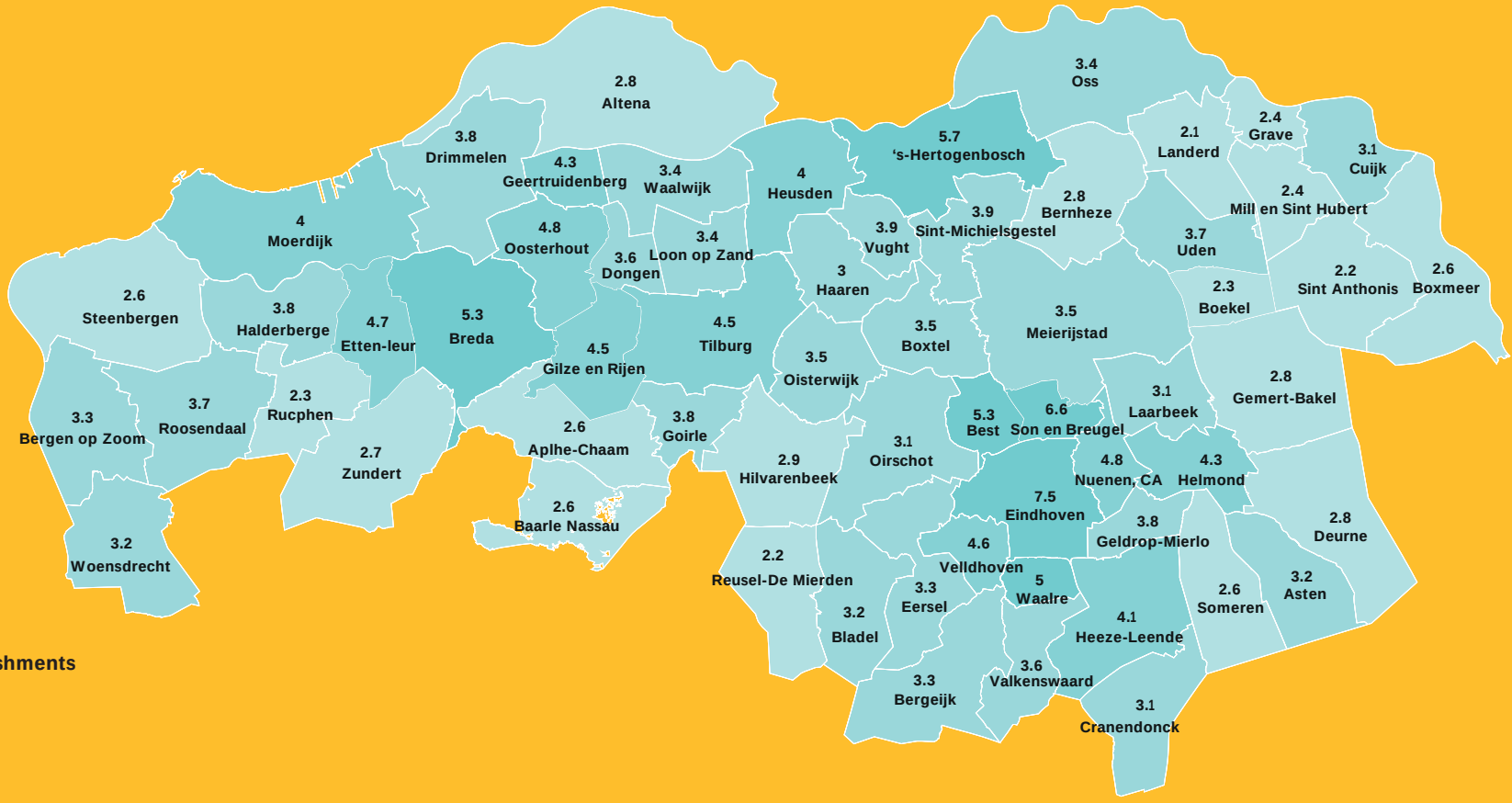


Establishments in ICT by municipality

- Less than 50
- 50 - 100
- 100 - 250
- 250 - 500
- 500 - 1.000
- More than 1.000

Source: Brabant Register of Establishments, 2019, QGIS, edited by Fanion Onderzoek & Advies

SHARE OF IT COMPANIES BY MUNICIPALITY

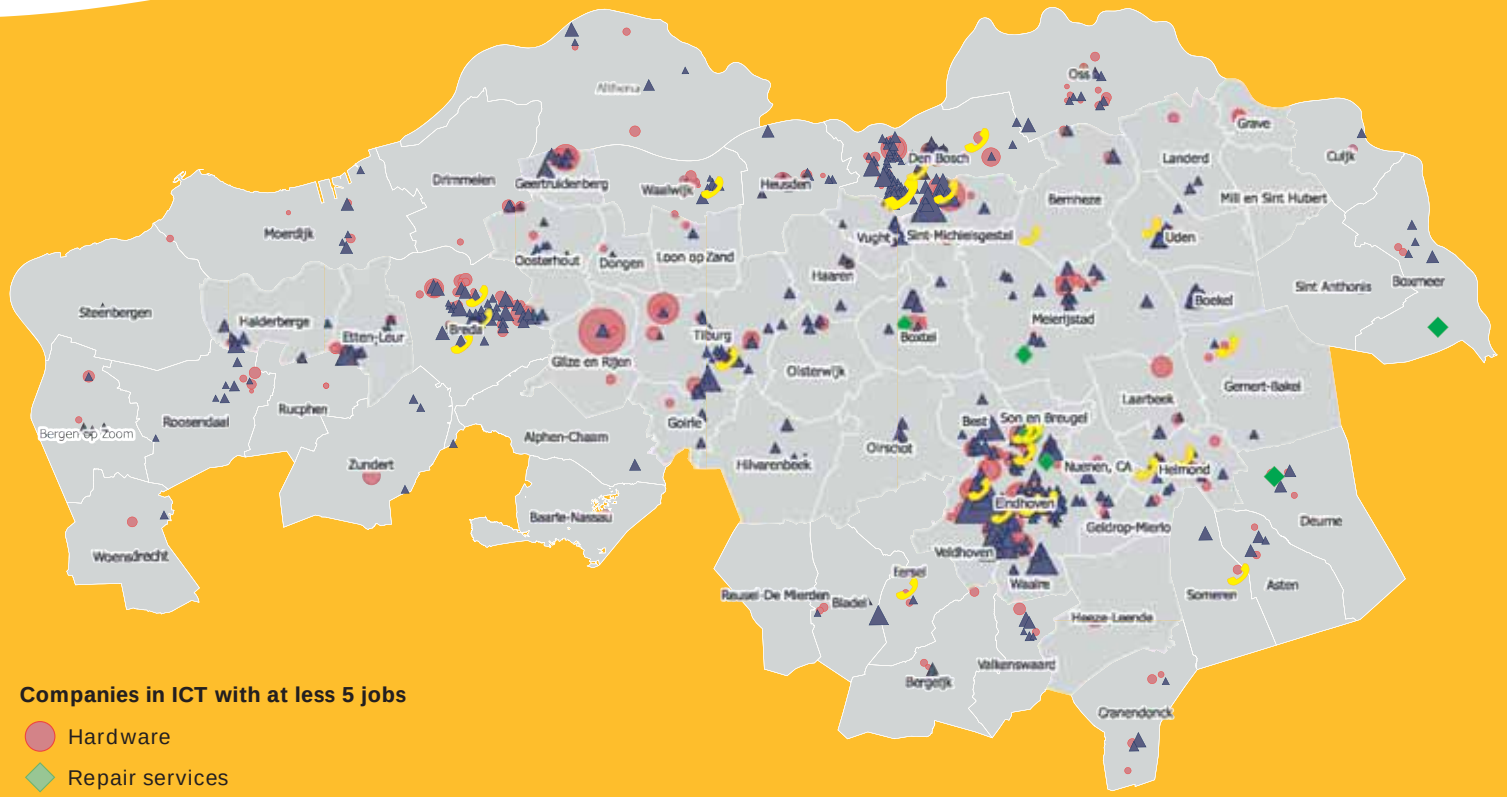


Share ICT in total of establishments

- Less than 1%
- 1 - 2%
- 2 - 3%
- 3 - 4%
- 4 - 5%
- More than 5%

Source: Brabant Register of Establishments, 2019, QGIS, edited by Fanion Onderzoek & Advies

SPREAD OF COMPANIES EMPLOYING MORE THAN 5 PEOPLE, BY SUBSECTOR



Companies in ICT with at less 5 jobs

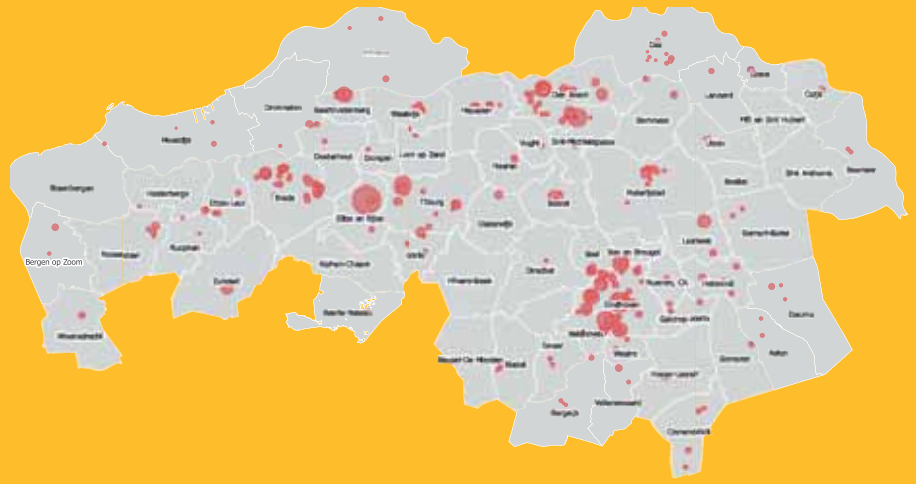
- Hardware
- Repair services
- Software and IT services
- Telecommunication

The largest IT companies are found in the cities of Eindhoven, Den Bosch, and Gilze-Rijen. Hardware companies are mostly located in the Eindhoven/ Helmond region, generally around the city of Eindhoven. However, Den Bosch is also home to numerous major hardware manufacturers. Software and IT services companies are largely concentrated in the major cities of Eindhoven, Den Bosch, and Breda. Smaller software and IT services companies are more widely spread around Brabant.

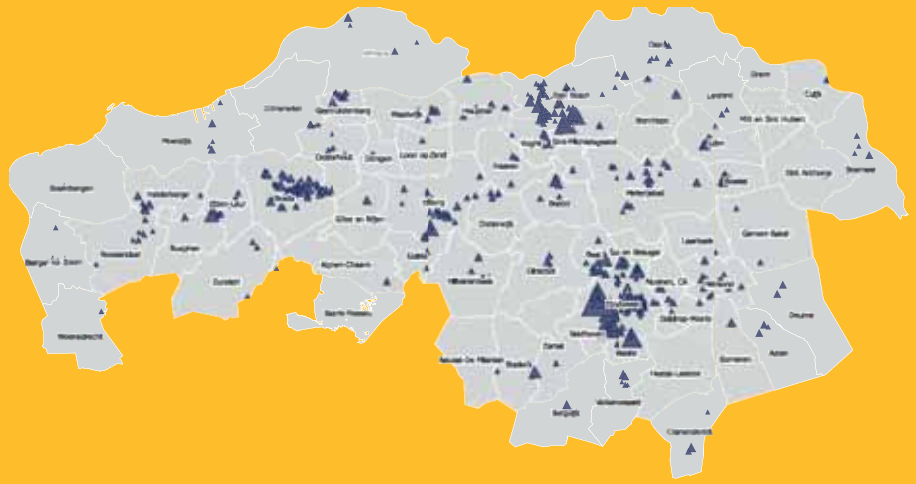
Specialist telecommunications companies also tend to be congregated around Eindhoven and Den Bosch.
Repair services businesses tend to be relatively small, with the larger ones are concentrated in the eastern part of Brabant.

Source: Brabant Register of Establishments, 2019, QGIS, edited by Fanion Onderzoek & Advies

SPREAD OF HARDWARE SUBINDUSTRY COMPANIES EMPLOYING MORE THAN 5 PEOPLE

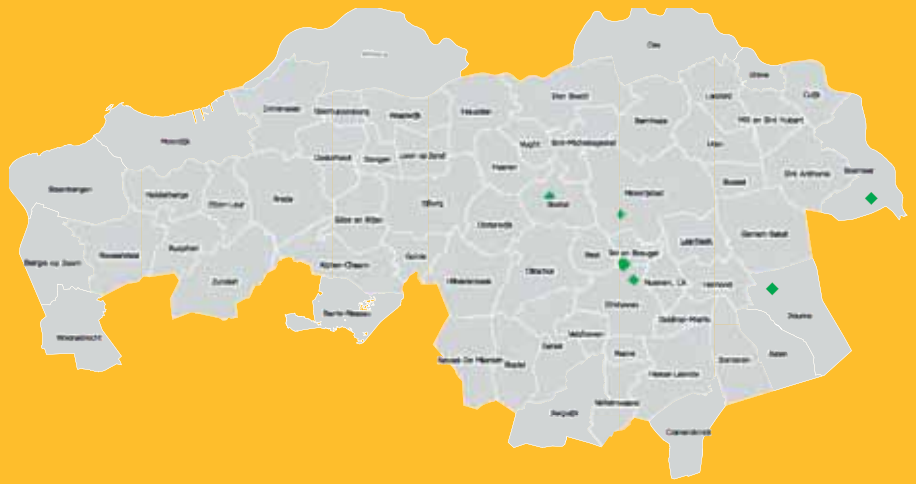


SPREAD OF SOFTWARE AND IT SERVICES SUBINDUSTRY COMPANIES EMPLOYING MORE THAN 5 PEOPLE



SPREAD OF TELECOMMUNICATIONS SUBINDUSTRY COMPANIES EMPLOYING MORE THAN 5 PEOPLE

SPREAD OF REPAIR SERVICES SUBINDUSTRY COMPANIES EMPLOYING MORE THAN 5 PEOPLE



Source: Brabant Register of Establishments, 2019, QGIS, edited by Fanion Onderzoek & Advies

5. Large IT & Data Science companies and their official subindustries

THE 25 LARGEST HARDWARE COMPANIES IN THE PROVINCE ARE:

	Name	City	Activity	Company size
1	**Ericsson Telecommunicatie**	Rijen	IT service provider	500-1,000
2	**Bosch Security Systems**	Eindhoven	Security and surveillance systems	200-500
3	**Copaco Nederland**	Eindhoven	Security and surveillance systems	200-500
4	**Ingram Micro CFS Benelux**	Tilburg	E-fulfilment specialist	200-500
5	**Nedis**	Den Bosch	Wholesale in IT hardware	200-500
6	**Itsme**	Raamsdonksveer	Wholesale in electronic components and devices	200-500
7	**Omron Manufacturing of the Netherlands**	Den Bosch	Electronic components and devices	200-500
8	**Neways Industrial Systems**	Son en Breugel	Electronic systems	200-500
9	**VHE Industrial Automation**	Eindhoven	Industrial automation	100-200
10	**Legrand Nederland**	Boxtel	IT infrastructure equipment	100-200
11	**Dialog Semiconductor**	Den Bosch	Semiconductors	100-200
12	**Bechtle direct**	Eindhoven	Wholesale in IT hardware and IT solutions	100-200
13	**Teledyne DALSA**	Eindhoven	Imaging and microelectromechanical systems	100-200
14	**Molex Interconnect**	Eindhoven	Wholesale in electronic components and devices	100-200
15	**MAG 45**	Eindhoven	Integrated supply solutions	100-200
16	**Acer Computer**	Den Bosch	Computers	100-200
17	**MyMicro Group**	Beek en Donk	Hardware replacement parts	100-200
18	**CLB Integrated Solutions**	Raamsdonksveer	IT and early-warning systems for healthcare	100-200
19	**The Swatch Group (Netherlands) B.V.**	Eindhoven	Watches	100-200
20	**Orange Climate Energy & Comfort**	Drunen	Climate control systems	100-200
21	**ComServe Network Netherlands B.V.**	Rosmalen	Aftersales and repair services for electronics	100-200
22	**Grass Valley Nederland B.V.**	Breda	Audiovisual equipment	100-200
23	**Skalar Analytical B.V.**	Breda	Chemical analyzers	100-200
24	**Zetes B.V.**	Son en Breugel	Supply chain systems	50-100
25	**Rena Operations B.V.**	Zundert	Wholesale in lighting and electronics	50-100

Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

THE 25 LARGEST SOFTWARE AND SERVICES COMPANIES ARE:

	Name	City	Activity	Company size
1	**Atos Nederland**	Eindhoven	Digital services	500-1,000
2	**SAP Nederland**	Den Bosch	Business process management (BPM) software	500-1,000
3	**IT Group**	Bergen op Zoom, Oosterhout, Eindhoven	Integrated IT system solutions	200-500
4	**Simac IT Nederland**	Veldhoven	High-quality technological solutions for business processes	200-500
5	**Sogeti**	Eindhoven	Digital services	200-500
6	**Ctac**	Den Bosch	Business and cloud integration	200-500
7	**Dassault Systèmes**	Den Bosch	Smart system provider and integrator	200-500
8	**PinkRoccade Healthcare**	Den Bosch	Digital healthcare services	200-500
9	**Super Micro Computer**	Den Bosch	Computer hardware	200-500
10	**Acknowledge Professional services**	Waalre	IT and cloud services	200-500
11	**Blueriq**	Den Bosch	Financial software	200-500
12	**PharmaPartners**	Oosterhout	IT solutions for the pharmaceutical industry	100-200
13	**Vecozo.**	Tilburg	Digital communication health	100-200
14	**Itelligence**	Eindhoven	IT solutions	100-200
15	**Sioux Embedded Systems**	Eindhoven	Smart system provider and integrator	100-200
16	**Itility Beheer**	Eindhoven	Data and cloud solutions	100-200
17	**Topic Embedded systems**	Best	Embedded software and digital hardware	100-200
18	**OGD Eindhoven**	Eindhoven	IT services and software development	100-200
19	**SD Worx Nederland**	Breda	HRM and payroll services	100-200
20	**GAC Group of Companies**	Oirschot	Business software and consultancy	100-200
21	**Schouw Informatisering**	Etten-Leur	IT solutions for the food industry	100-200
22	**BCS HRM en Salarisadministratie**	Den Bosch	HRM and payroll services	100-200
23	**Advantech Europe**	Son en Breugel	Embedded software and digital solutions	100-200
24	**Vanboxtel**	Boekel	Logistics and order pick solutions	100-200
25	**myBrand**	Geertruidenberg	Business process management (BPM) software	100-200

Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

THE 10 LARGEST TELECOMMUNICATIONS COMPANIES ARE:

	Name	City	Activity	Company size
1	**Ericsson**	Rijen	IT service provider	500-1,000
2	**KPN**	s'-Hertogenbosch/Eindhoven/ Son en Breugel/Tilburg/Uden/Waalwijk	Telecommunication services	500-1,000
3	**CM.com**	Breda	Cloud software for conversational commerce	50-100
4	**InterConnect Services**	Den Bosch	IT services	50-100
5	**X2Com**	Rosmalen	Telecommunications services	20-50
6	**Ziggo Services**	Helmond	Telecommunications services	20-50
7	**Network Innovations**	Eersel	Communication and network solutions	10-20
8	**Qteco**	Eindhoven	IT and telecom services	10-20
9	**Voips**	Gemert	Business telecom and internet	10-20
10	**BoFa Telefoondienst**	Eindhoven	Phone services	10-20

THE 10 LARGEST REPAIR SERVICES COMPANIES ARE:

	Name	City	Activity	Company size
1	**Mainteq Europe B.V.**	Son en Breugel	Service provider, LCD monitors	20-50
2	**Hanaro**	Deurne	Telecom services	20-50
3	**Gsm Eindhoven**	Eindhoven	Phone repair services	10-20
4	**IXON Base B.V.**	Overloon	Telecommunications and IT services	10-20
5	**ICteam Zuid B.V.**	Sint-Oedenrode	Repair services	< 10
6	**Snew circulair Telecom and IT**	Boxtel	Refurbishment of IT hardware	< 10
7	**Vedacom**	Budel	IT and telecommunications services	< 10
8	**IT Werkplaats Eindhoven**	Eindhoven	Computer repair services	< 10
9	**Sabes Group B.V.**	Bladel	Smartphone, tabled and computer repair services	< 10
10	**Fastfix IT Support**	Breda	Smartphone, tabled and computer repair and telecommunications services	< 10

Source: Brabant Register of Establishments, 2019, edited by Fanion Onderzoek & Advies

THE 28 LARGEST HTSM COMPANIES WITH A CLOSE LINK TO IT ARE:

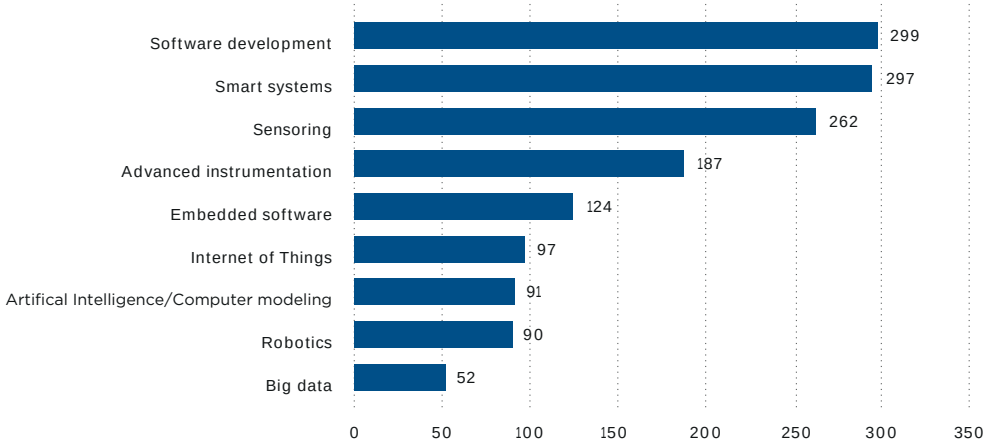
	Name	City	Activity	Size category jobs
1	**ASML**	Veldhoven	Wafer stepper machines	>1,000
2	**Philips Innovation services**	Eindhoven	Testing and research facilities and services	>1,000
3	**Signify**	Eindhoven	Lighting solutions	>1,000
4	**TNO**	Helmond/Eindhoven	Testing and research facilities and services	200-500
5	**TE Connectivity Nederland**	Den Bosch	Connectors and sensors	200-500
6	**Modine Uden**	Uden	Heat transfer products	200-500
7	**Here Global**	Eindhoven	Maps and navigation software	200-500
8	**TMC**	Eindhoven	High-tech consultancy	200-500
9	**Altran (TASS)**	Eindhoven	IT and R&D consultancy	200-500
10	**Kulicke & Soffa Netherlands**	Eindhoven	Semiconductor and electronic assembly solutions	100-200
11	**Fluor Consultants**	Bergen op Zoom	Engineering and technical services	100-200
12	**Vodafone Customer Solution Center**	Eindhoven	Customer service center	100-200
13	**Altran engineering**	Helmond	IT and R&D consultancy	100-200
14	**Systemair**	Waalwijk	Air treatment and ventilation systems	100-200
15	**Mapscape**	Eindhoven	Digital maps and navigation	100-200
16	**Tech Mahindra**	s'-Hertogenbosch	Cable infrastructure	100-200
17	**Stichting IMEC Nederland**	Eindhoven	R&D hub for nano- and digital technologies	100-200
18	**Aggreko Nederland**	Klundert	Rental industrial equipment	100-200
19	**INTO Telecom & IT**	Breda	Telecommunication and digital workspaces	100-200
20	**ABB**	Eindhoven	Industrial automation	50-100
21	**Lapp Benelux**	Waalre	Parts for IT systems: cables/connectors	20-50
22	**Raith**	Best	Nanolithography	20-50
23	**Anderis Engineering**	Biest-Houtakker	Secondment and outsourcing of IT engineers	20-50
24	**Inkubis BV- i Advise**	Breda	Solutions for digital services	20-50
25	**TMC Test & Integration**	Eindhoven	High-tech consultancy	20-50
26	**Intelectric Installation Resources**	Eersel	Electrotechnical installation technology	20-50
27	**Hendrikx Matrijzen en Prototypen**	Oisterwijk	Development, production, maintenance, and sale of molds	20-50
28	**Alten DDA**	Eindhoven	Consultancy and engineering	20-50

Source: Brabant Register of Establishments, 2018/Fanion Onderzoek & Advies

6. HTSM companies active in IT & Data Science and with much expertise in those fields

Research has been conducted on the 1,560 largest companies in the High-tech Systems and Maintenance priority industry, a sector that partly overlaps with the IT sector. The study looked at the technologies that companies use, with the outcome being that 300 companies are involved in software development, nearly 300 companies are involved in smart systems, 262 companies have expertise in sensors, 187 in advanced instrumentation, and 124 companies focus on embedded software.

NUMBER OF HTSM COMPANIES (EMPLOYING MORE TEN PEOPLE) WITH EXPERTISE IN IT DOMAINS



Source: Fanion Onderzoek & Advies, based on the Brabant Register of Establishments, commissioned by BOM, 2020

25 IMPORTANT HTSM COMPANIES ACTIVE IN SOFTWARE DEVELOPMENT

	Name	Place	Activity	Company size in jobs
1	**Philips Health Care**	Best	Medical systems	> 2,500
2	**Philips Innovation services**	Eindhoven	Testing and research facilities and services	> 2,000
3	**Vanderlande Industries B.V.**	Veghel	Value-added logistic process automation at airports	>1,500
4	**Atos Nederland B.V.**	Eindhoven	Digital services	700-800
5	**VDL Enabling Technologies Group Eindh. B.V.**	Eindhoven	Mechatronic modules	600-700
6	**SAP Nederland B.V.**	Den Bosch	Business process management (BPM) software	400-500
7	**Bosch Security Systems B.V.**	Eindhoven	Security and surveillance systems	300-400
8	**Dassault Systemes B.V.**	Den Bosch	Smart system provider and integrator	300-400
9	**PinkRoccade Local Government**	Den Bosch	Software for local government	200-300
10	**Super Micro Computer B.V.**	Den Bosch	Computer hardware	200-250
11	**Here Global B.V.**	Eindhoven	Maps and navigation software	200-250
12	**VDL ETG Precision B.V.**	Eindhoven	Mechatronic modules	200-250
13	**Altran (TASS)**	Eindhoven	IT and R&D consultancy	100-200
14	**PharmaPartners B.V.**	Oosterhout	IT solutions for the pharmaceutical industry	100-200
15	**Sioux Embedded Systems B.V.**	Eindhoven	Smart system provider and integrator	100-200
16	**Vodafone Customer Solution Center**	Eindhoven	Customer service center	100-200
17	**Altran engineering B.V.**	Helmond	IT and R&D consultancy	100-200
18	**Vecozo B.V.**	Tilburg	Digital communication health	100-200
19	**Vanboxtel B.V.**	Boekel	Logistics and order picking solutions	100-200
20	**Schouw Informatisering B.V.**	Etten-Leur	IT solutions for the food industry	100-200
21	**BCS HRM en Salarisadministratie B.V.**	Den Bosch	HRM and payroll services	100-200
22	**VDL ETG Research B.V.**	Eindhoven	Mechatronic modules	100-200
23	**Mapscape B.V.**	Eindhoven	Digital maps and navigation	100-200
24	**CGI Nederland B.V.**	Eindhoven	IT and business consulting services	100-200
25	**GameHouse Europe B.V.**	Eindhoven	Game development	100-200

Source: Fanion Onderzoek & Advies, based on the Brabant Register of Establishments, commissioned by BOM, 2020

25 IMPORTANT HTSM COMPANIES ACTIVE IN SMART SYSTEMS

	Name	Place	Activity	Company size in jobs
1	**ASML Netherlands B.V.**	Veldhoven	Semiconductor machines	> 7,500
2	**Philips Health Care**	Best	Medical systems	> 2,500
3	**Philips Innovation services**	Eindhoven	Testing and research facilities and services	> 2,000
4	**Vanderlande Industries B.V.**	Veghel	Value-added logistic process automation at airports	> 1,500
5	**Signify**	Eindhoven	Lighting solutions	> 1,000
6	**Prodrive Technologies B.V.**	Son en Breugel	System supplier	> 1,000
7	**Marel Stork Poultry Processing B.V.**	Boxmeer	Poultry, meat, and fish processing systems	800-900
8	**Thermo Fisher Scientific (FEI Electron Optics B.V.)**	Eindhoven	Electron microscopes	600-700
9	**VDL Enabling Technologies Group Eindh. B.V.**	Eindhoven	Mechatronic modules	600-700
10	**SAP Nederland B.V.**	Den Bosch	Business process management (BPM) software	400-500
11	**Wärtsila Netherlands BV**	Drunen	Maritime solutions	400-500
12	**Gea food solutions bakel B.V.**	Bakel	Air treatment and ventilation systems	400-500
13	**Kuhn-Geldrop B.V.**	Geldrop	Farm machinery	300-400
14	**Dassault Systemes B.V.**	Den Bosch	Smart system provider and integrator	300-400
15	**Vencomatic Group**	Eersel	Poultry systems	300-400
16	**Here Global B.V.**	Eindhoven	Maps and navigation software	200-300
17	**VDL ETG Precision B.V.**	Eindhoven	Mechatronic modules	200-300
18	**Applied Micro Electronics "Ame" B.V.**	Eindhoven	High-quality electronic products	200-300
19	**AAE Advanced Automated Equipment B.V.**	Helmond	Mechatronic modules	200-300
20	**Altran (TASS)**	Eindhoven	IT and R&D consultancy	200-300
21	**Omron Manufacturing of the Netherlands B.V.**	Den Bosch	Electronic components and devices	100-200
22	**Benier Nederland B.V.**	Nieuwkuijk	Bakery machinery	100-200
23	**KSE Procest Technologie B.V.**	Bladel	Dosing and weighing systems	100-200
24	**VDL ETG Technology & Development B.V.**	Eindhoven	Mechatronic modules	100-200
25	**Sioux Embedded Systems B.V.**	Eindhoven	Smart systems provider and integrator	100-200

25 IMPORTANT HTSM COMPANIES ACTIVE IN SENSORS

	Name	Place	Activity	Company size in jobs
1	**ASML Netherlands B.V.**	Veldhoven	Semiconductor machines	> 7,500
2	**Philips Health Care**	Best	Medical systems	> 2,500
3	**Philips Innovation services**	Eindhoven	Testing and research facilities and services	> 2,000
4	**Vanderlande Industries B.V.**	Veghel	Value-added logistic process automation at airports	> 1,500
5	**Signify**	Eindhoven	Lighting solutions	> 1,000
6	**Prodrive Technologies B.V.**	Son en Breugel	System supplier	> 1,000
7	**Thermo Fisher Scientific (FEI Electron Optics B.V.)**	Eindhoven	Electron microscopes	600-700
8	**VDL Enabling Technologies Group Eindh. B.V.**	Eindhoven	Mechatronic modules	600-700
9	**Ericsson Telecommunicatie B.V.**	Rijen	IT service provider	500-600
10	**Fokker Elmo B.V.**	Hoogerheide	Aircraft cabling	500-600
11	**Gea food solutions bakel B.V.**	Bakel	Air treatment and ventilation systems	400-500
12	**Bosch Security Systems B.V.**	Eindhoven	Security and surveillance systems	300-400
13	**Dassault Systemes B.V.**	Den Bosch	Smart systems provider and integrator	300-400
14	**Vencomatic Group**	Eersel	Poultry systems	300-400
15	**Modine Uden B.V.**	Uden	Heat-transfer products	200-300
16	**Here Global B.V.**	Eindhoven	Maps and navigation software	200-300
17	**VDL ETG Precision B.V.**	Eindhoven	Mechatronic modules	200-300
18	**Applied Micro Electronics "Ame" B.V.**	Eindhoven	High-quality electronic products	200-300
19	**Altran (TASS)**	Eindhoven	IT and R&D consultancy	200-300
20	**Omron Manufacturing of the Netherlands B.V.**	Den Bosch	Electronic components and devices	100-200
21	**NRF B.V.**	Mill	Cooling technology	100-200
22	**Neways Industrial Systems B.V.**	Son en Breugel	Electronic systems	100-200
23	**Benier Nederland B.V.**	Nieuwkuijk	Bakery machinery	100-200
24	**KSE Procest Technologie B.V.**	Bladel	Dosing and weighing systems	100-200
25	**VDL ETG Technology & Development B.V.**	Eindhoven	Mechatronic modules	100-200

25 IMPORTANT HTSM COMPANIES ACTIVE IN ADVANCED INSTRUMENTS

	Name	Place	Activity	Company size in jobs
1	**ASML Netherlands B.V.**	Veldhoven	Semiconductor machines	> 7,500
2	**Philips Health Care**	Best	Medical systems	> 2,500
3	**Philips Innovation services**	Eindhoven	Testing and research facilities and services	> 2,000
4	**Vanderlande Industries B.V.**	Veghel	Value-added logistic process automation at airports	> 1,500
5	**Prodrive Technologies B.V.**	Son en Breugel	Systems supplier	> 1,000
6	**Atos Nederland B.V.**	Eindhoven	Digital services	700-800
7	**Thermo Fisher Scientific (FEI Electron Optics B.V.)**	Eindhoven	Electron microscopes	600-700
8	**VDL Enabling Technologies Group Eindh. B.V.**	Eindhoven	Mechatronic modules	600-700
9	**Bosch Rexroth BV**	Boxtel	Machine parts and modules	500-600
10	**Ericsson Telecommunicatie B.V.**	Rijen	IT service provider	500-600
11	**Bosch Security Systems B.V.**	Eindhoven	Security and surveillance systems	300-400
12	**Dassault Systemes B.V**	Den Bosch	Smart system provider and integrator	300-400
13	**Modine Uden B.V.**	Uden	Heat-transfer products	200-300
14	**Omron Manufacturing of the Netherlands B.V.**	Den Bosch	Electronic components and devices	100-200
15	**Neways Industrial Systems B.V.**	Son en Breugel	Electronic systems	100-200
16	**KTBA Kwaliteitszorg B.V.**	Kaatsheuvel	Quality assurance	100-200
17	**TüV Nederland QA B.V.**	Best	Inspection and certification services	100-200
18	**VDL ETG Technology & Development B.V.**	Eindhoven	Mechatronic modules	100-200
19	**Neways Technologies B.V.**	Son en Breugel	Electronic systems	100-200
20	**VDL ETG Research B.V.**	Eindhoven	Mechatronic modules	100-200
21	**Teledyne Dalsa B.V.**	Eindhoven	Imaging and microelectromechanical systems	100-200
22	**Vinçotte Nederland B.V.**	Breda	Inspection and certification services	100-200
23	**Stichting IMEC Nederland**	Eindhoven	R&D hub for nano- and digital technologies	100-200
24	**Grass Valley Nederland B.V.**	Breda	Audiovisual equipment	100-200
25	**TNO**	Helmond	Testing and research facilities and services	100-200

25 IMPORTANT HTSM COMPANIES ACTIVE IN EMBEDDED SOFTWARE DEVELOPMENT

	Name	Place	Activity	Company size in jobs
1	**ASML Netherlands B.V.**	Veldhoven	Systems supplier	> 1,000
2	**Philips Health Care**	Best	Mechatronic modules	600-700
3	**Philips Innovation services**	Eindhoven	IT service provider	500-600
4	**Vanderlande Industries B.V.**	Veghel	Maritime solutions	400-500
5	**Prodrive Technologies B.V.**	Son en Breugel	Smart systems provider and integrator	300-400
6	**VDL Enabling Technologies Group Eindh. B.V.**	Eindhoven	Mechatronic modules	200-300
7	**Ericsson Telecommunicatie B.V.**	Rijen	High-quality electronic products	200-300
8	**Wärtsila Netherlands BV**	Drunen	IT and R&D consultancy	200-300
9	**Dassault Systemes B.V**	Den Bosch	Mechatronic modules	100-200
10	**Applied Micro Electronics "Ame" B.V.**	Eindhoven	Semiconductors	100-200
11	**Altran (TASS)**	Eindhoven	IT and R&D consultancy	100-200
12	**VDL ETG Technology & Development B.V.**	Eindhoven	Logistics and order picking solutions	100-200
13	**Sioux Embedded Systems B.V.**	Eindhoven	Mechatronic modules	100-200
14	**Dialog Semiconductor B.V.**	Den Bosch	Digital maps and navigation	100-200
15	**Altran engineering B.V.**	Helmond	Handling systems	100-200
16	**Vanboxtel B.V.**	Boekel	Semifinished machine modules	100-200
17	**VDL ETG Research B.V.**	Eindhoven	Testing and research facilities and services	100-200
18	**Mapscape B.V.**	Eindhoven	Industrial software	100-200
19	**Verhoeven Oss**	Oss	Electrical engineering, industrial automation, and production IT	50-100
20	**Frencken Mechatronics B.V.**	Eindhoven	Testing and research facilities and services	50-100
21	**TNO**	Helmond	Machines for the chemical, physical, and structural analysis of materials	50-100
22	**Siemens Industry Software B.V.**	Den Bosch	Industrial cameras	50-100
23	**TNO**	Eindhoven	Testing and research facilities and services	50-100
24	**Malvern Panalytical B.V.**	Eindhoven	Engineering consulting	50-100
25	**Adimec**	Eindhoven	High-tech consultancy	50-100

Source: Fanion Onderzoek & Advies, based on the Brabant Register of Establishments, commissioned by BOM, 2020

25 IMPORTANT HTSM COMPANIES ACTIVE IN THE INTERNET OF THINGS

	Name	Place	Activity	Company size in jobs
1	**Philips Innovation services**	Eindhoven	Testing and research facilities and services	> 2,000
2	**Signify**	Eindhoven	Lighting solutions	> 1,000
3	**Atos Nederland B.V.**	Eindhoven	Digital services	700-800
4	**Ericsson Telecommunicatie B.V.**	Rijen	IT service provider	500-600
5	**SAP Nederland B.V.**	Den Bosch	Business process management (BPM) software	400-500
6	**Dassault Systemes B.V**	Den Bosch	Smart systems provider and integrator	300-400
7	**Super Micro Computer B.V.**	Den Bosch	Computer hardware	200-300
8	**Here Global B.V.**	Eindhoven	Maps and navigation software	200-300
9	**Applied Micro Electronics "Ame" B.V.**	Eindhoven	High-quality electronic products	200-300
10	**Altran (TASS)**	Eindhoven	IT and R&D consultancy	200-300
11	**Altran engineering B.V.**	Helmond	IT and R&D consultancy	100-200
12	**Vanboxtel B.V.**	Boekel	Logistics and order picking solutions	100-200
13	**CGI Nederland B.V.**	Eindhoven	IT and business consulting services	100-200
14	**Stichting IMEC Nederland**	Eindhoven	R&D hub for nano and digital technologies	100-200
15	**TNO**	Helmond	Testing and research facilities and services	100-200
16	**Siemens Industry Software B.V.**	Den Bosch	Industrial software	100-200
17	**Actemium**	Veghel	Industrial automation and solutions	100-200
18	**INTO Telecom & IT B.V.**	Breda	Telecommunications and digital workspaces	100-200
19	**TNO**	Eindhoven	Testing and research facilities and services	50-100
20	**Wemo Nederland B.V.**	Den Bosch	Sheet metal products	50-100
21	**TNO**	Eindhoven	Testing and research facilities and services	50-100
22	**Tokheim Netherlands**	Bladel	Fuel systems	50-100
23	**HERE Europe B.V.**	Eindhoven	Maps and navigation software	50-100
24	**EldoLED B.V.**	Son en Breugel	Design and manufacture of intelligent drive solutions for LED-based lighting systems	50-100
25	**TMC Mechatronics B.V.**	Eindhoven	High-tech consultancy	50-100

Source: Fanion Onderzoek & Advies, based on the Brabant Register of Establishments, commissioned by BOM, 2020

25 IMPORTANT HTSM COMPANIES ACTIVE IN ARTIFICIAL INTELLIGENCE

	Name	Place	Activity	Company size in jobs
1	**Philips Health Care**	Best	Medical systems	> 2,500
2	**Philips Innovation services**	Eindhoven	Testing and research facilities and services	> 2,000
3	**Atos Nederland B.V.**	Eindhoven	Digital services	600-700
4	**Thermo Fisher Scientific (FEI Electron Optics B.V.)**	Eindhoven	Electron microscopes	600-700
5	**Dassault Systemes B.V**	Den Bosch	Smart systems provider and integrator	300-400
6	**Applied Micro Electronics "Ame" B.V.**	Eindhoven	High-quality electronic products	200-300
7	**Altran (TASS)**	Eindhoven	IT and R&D consultancy	200-300
8	**Fluor Consultants B.V.**	Bergen op Zoom	Engineering and technical services	100-200
9	**Altran engineering B.V.**	Helmond	IT and R&D consultancy	100-200
10	**Mapscape B.V.**	Eindhoven	Digital maps and navigation	100-200
11	**GameHouse Europe B.V.**	Eindhoven	Game development	100-200
12	**Stichting IMEC Nederland**	Eindhoven	R&D hub for nano and digital technologies	100-200
13	**Grass Valley Nederland B.V.**	Breda	Audiovisual equipment	100-200
14	**Siemens Industry Software B.V.**	Den Bosch	Industrial software	100-200
15	**Wemo Nederland B.V.**	Den Bosch	Sheet metal products	50-100
16	**Strukton Worksphere**	Breda	Smart building development	50-100
17	**TMC Mechatronics B.V.**	Eindhoven	High-tech consultancy	50-100
18	**Epic Den Bosch B.V.**	Den Bosch	Software for the healthcare sector	50-100
19	**TMC Field Service Eindhoven B.V.**	Eindhoven	High-tech consultancy	50-100
20	**Siemens Industry Software B.V.**	Breda	Industrial software	50-100
21	**Geodan B.V.**	Den Bosch	GIS systems and mapping	50-100
22	**RPS advies- en ingenieursbureau**	Breda	Spatial engineering	0-50
23	**Friends4Dents**	Rosmalen	Dental technology prosthetics	0-50
24	**TMC Civiele Techniek B.V.**	Eindhoven	High-tech consultancy	0-50
25	**Itility B.V.**	Eindhoven	Data and cloud solutions	0-50

Source: Fanion Onderzoek & Advies, based on the Brabant Register of Establishments, commissioned by BOM, 2020

25 IMPORTANT HTSM COMPANIES ACTIVE IN ROBOTICS

	Name	Place	Activity	Company size in jobs
1	**Philips Health Care**	Best	Medical systems	> 2,500
2	**Vanderlande Industries B.V.**	Veghel	Value-added logistic process automation at airports	> 1,500
3	**VDL Enabling Technologies Group Eindh. B.V.**	Eindhoven	Mechatronic modules	600-700
4	**VDL Steelweld B.V.**	Breda	Production systems, special products, automated vehicles and parking systems	200-300
5	**VDL ETG Precision B.V.**	Eindhoven	Mechatronic modules	200-300
6	**Applied Micro Electronics "Ame" B.V.**	Eindhoven	High-quality electronic products	200-300
7	**Neways Industrial Systems B.V.**	Son en Breugel	Electronic systems	100-200
8	**VDL ETG Technology & Development B.V.**	Eindhoven	Mechatronic modules	100-200
9	**Sioux Embedded Systems B.V.**	Eindhoven	Smart systems provider and integrator	100-200
10	**Neways Technologies B.V.**	Son en Breugel	Electronic systems	100-200
11	**Altran engineering B.V.**	Helmond	IT and R&D consultancy	100-200
12	**VDL ETG Research B.V.**	Eindhoven	Mechatronic modules	100-200
13	**TNO**	Helmond	Testing and research facilities and services	100-200
14	**Siemens Industry Software B.V.**	Den Bosch	Industrial software	100-200
15	**Lan Handling Technologies B.V.**	Tilburg	Handling systems	50-100
16	**TNO**	Eindhoven	Testing and research facilities and services	50-100
17	**Bom Engineering B.V.**	Oud Gastel	Engineering and machine development	50-100
18	**TNO**	Eindhoven	Testing and research facilities and services	50-100
19	**A.C.E. Adviesbureau, Electrotechniek B.V.**	Eindhoven	Consultancy and engineering	50-100
20	**Vega-Systems B.V.**	Oss	Laundry and washing systems	50-100
21	**TNO**	Eindhoven	Testing and research facilities and services	50-100
22	**Brabant Engineering B.V.**	Best	Engineering consulting	50-100
23	**Besi (Meco Equipment Engineers B.V.)**	Drunen	Semiconductor equipment	50-100
24	**EKB groep zuid**	Someren	Industrial automation	50-100
25	**Neitraco - Cematec Engineering B.V.**	Roosendaal	Technical solutions and services	50-100

Source: Fanion Onderzoek & Advies, based on the Brabant Register of Establishments, commissioned by BOM, 2020

25 IMPORTANT HTSM COMPANIES ACTIVE IN BIG DATA

	Name	Place	Activity	Company size in jobs
1	**Philips Innovation Services**	Eindhoven	Testing and research facilities and services	> 2,500
2	**Atos Nederland B.V.**	Eindhoven	Digital services	700-800
3	**Thermo Fisher Scientific (FEI Electron Optics B.V.)**	Eindhoven	Electron microscopes	600-700
4	**SAP Nederland B.V.**	Den Bosch	Business process management (BPM) software	400-500
5	**Dassault Systemes B.V**	Den Bosch	Smart systems provider and integrator	300-400
6	**Super Micro Computer B.V.**	Den Bosch	Computer hardware	200-300
7	**Altran engineering B.V.**	Helmond	IT and R&D consultancy	100-200
8	**Vanboxtel B.V.**	Boekel	Logistics and order picking solutions	100-200
9	**Mapscape B.V.**	Eindhoven	Digital maps and navigation	100-200
10	**CGI Nederland B.V.**	Eindhoven	IT and business consulting services	100-200
11	**Stichting IMEC Nederland**	Eindhoven	R&D hub for nano and digital technologies	100-200
12	**Siemens Industry Software B.V.**	Den Bosch	Industrial software	100-200
13	**Strukton Worksphere**	Breda	Smart building development	50-100
14	**Epic Den Bosch B.V.**	Den Bosch	Software for the healthcare sector	50-100
15	**OCS Consulting BV**	Den Bosch	IT services and consultancy	0-50
16	**Ingram Micro CFS Technology B.V.**	Waalwijk	E-fulfillment and warehouse management	0-50
17	**Itility B.V.**	Eindhoven	Data and cloud solutions	0-50
18	**Anderis Engineering B.V.**	Biest-Houtakker	Secondment and outsourcing of IT engineers	0-50
19	**Hyarchis (VDD IQware B.V.)**	Eindhoven	Document management and business intelligence	0-50
20	**Inkubis BV- i Advise**	Breda	Solutions for digital services	0-50
21	**G2 Speech B.V.**	Nuenen	Speech recognition software	0-50
22	**Datacon Integration Solutions B.V.**	Tilburg	Integration of applications and data, API, and data management	0-50
23	**VAA (Van Aaken Automatisering)**	Rosmalen	IT and data science for AgriFood	0-50
24	**Process Gold (MagnaView B.V.)**	Eindhoven	Process mining and robot process automation	0-50
25	**Alten DDA B.V.**	Eindhoven	Consultancy and engineering	0-50

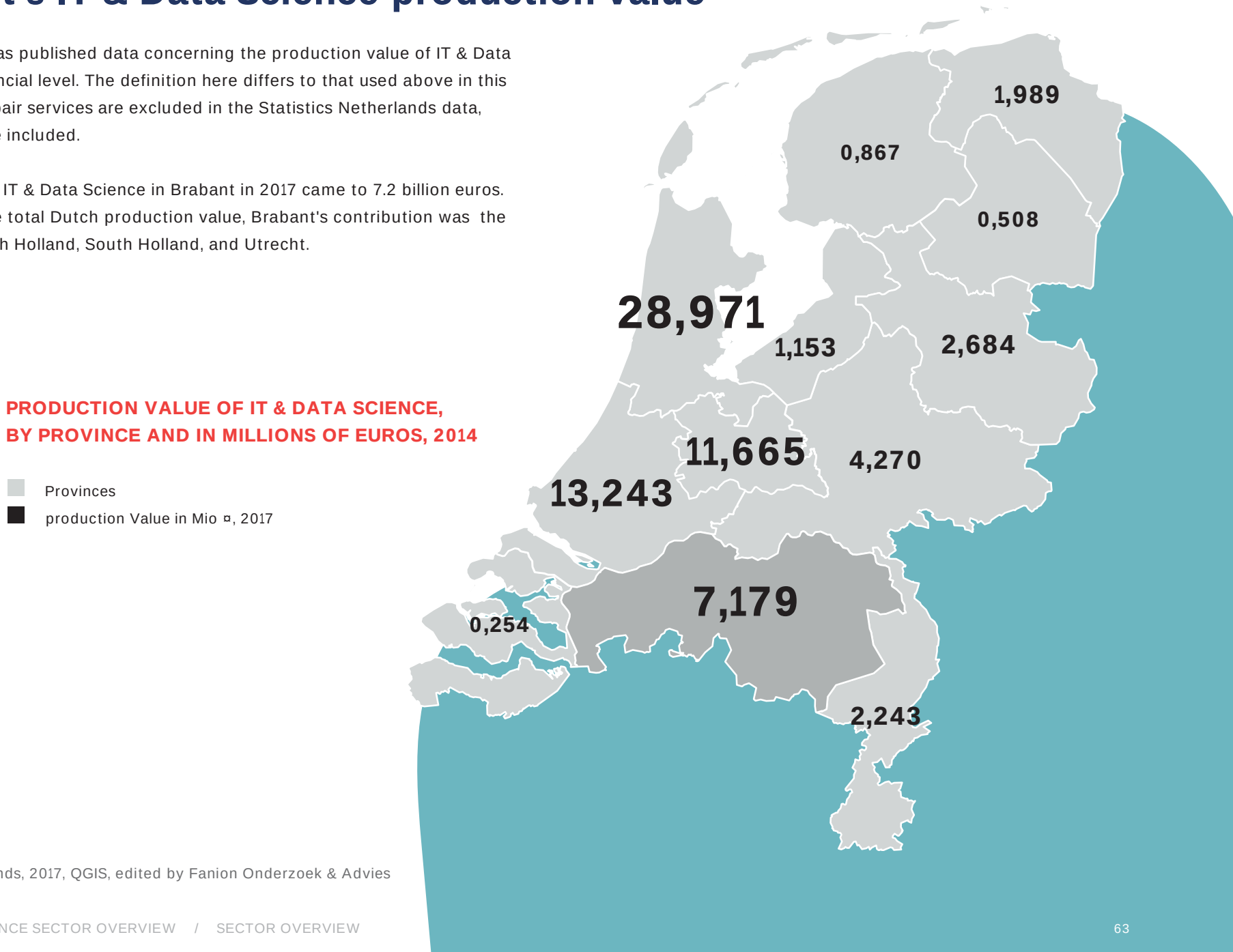
Source: Fanion Onderzoek & Advies, based on the Brabant Register of Establishments, commissioned by BOM, 2020

7. Brabant’s IT & Data Science production value

Statistics Netherlands has published data concerning the production value of IT & Data Science in 2017 at provincial level. The definition here differs to that used above in this study: hardware and repair services are excluded in the Statistics Netherlands data, while postal services are included.

The production value of IT & Data Science in Brabant in 2017 came to 7.2 billion euros. With a 9.6% share of the total Dutch production value, Brabant's contribution was the fourth largest after North Holland, South Holland, and Utrecht.

PRODUCTION VALUE OF IT & DATA SCIENCE, BY PROVINCE AND IN MILLIONS OF EUROS, 2014



Source: Statistics Netherlands, 2017, QGIS, edited by Fanion Onderzoek & Advies

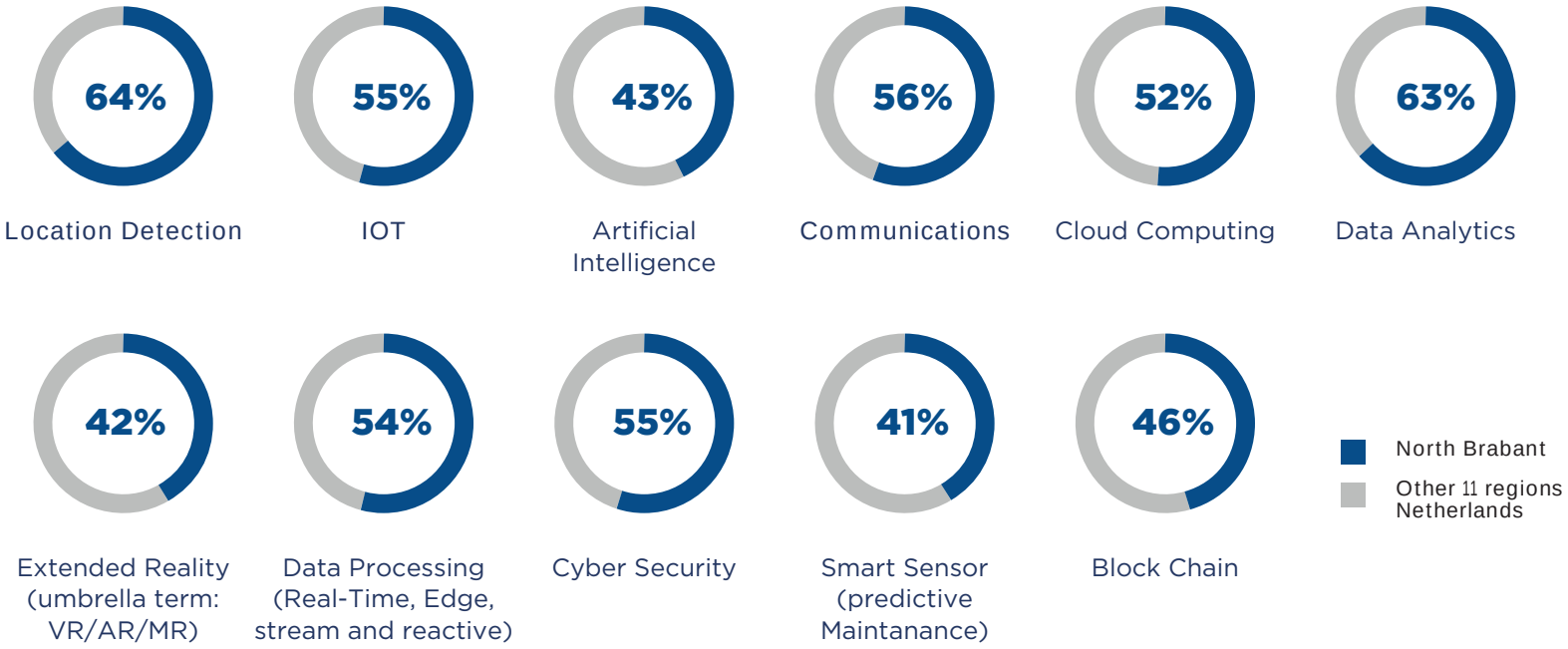
8. IT & Data Science patents in Brabant

MOST IT & DATA SCIENCE INNOVATIONS IN THE NETHERLANDS EMERGE FROM BRABANT.

A recent study, conducted by Sagacious IP, on patent applications in IT spearhead technologies shows that Brabant is responsible for more than half of the IT & Data Science patents in the Netherlands.

The largest number of patents relate to location detection (64%), followed by data analytics (63%), communication (56%) the IoT (55%), and cybersecurity (55%).

At present, a small number of patent applications pertain to the final field, cybersecurity. It is an emerging field and has only attracted much attention in recent years. The same holds true for the data processing.



(the figures are based on ten years of patent data from the Questel database. The research was conducted by Sagacious)

EXAMPLES OF BRABANT COMPANIES WITH IT SPEARHEAD PATENTS INCLUDE:

Philips

Signify Holding

HERE

NXP

ASML

SABIC

Lumideds Holding

Merck Sharp & Dhome

Intrinsic

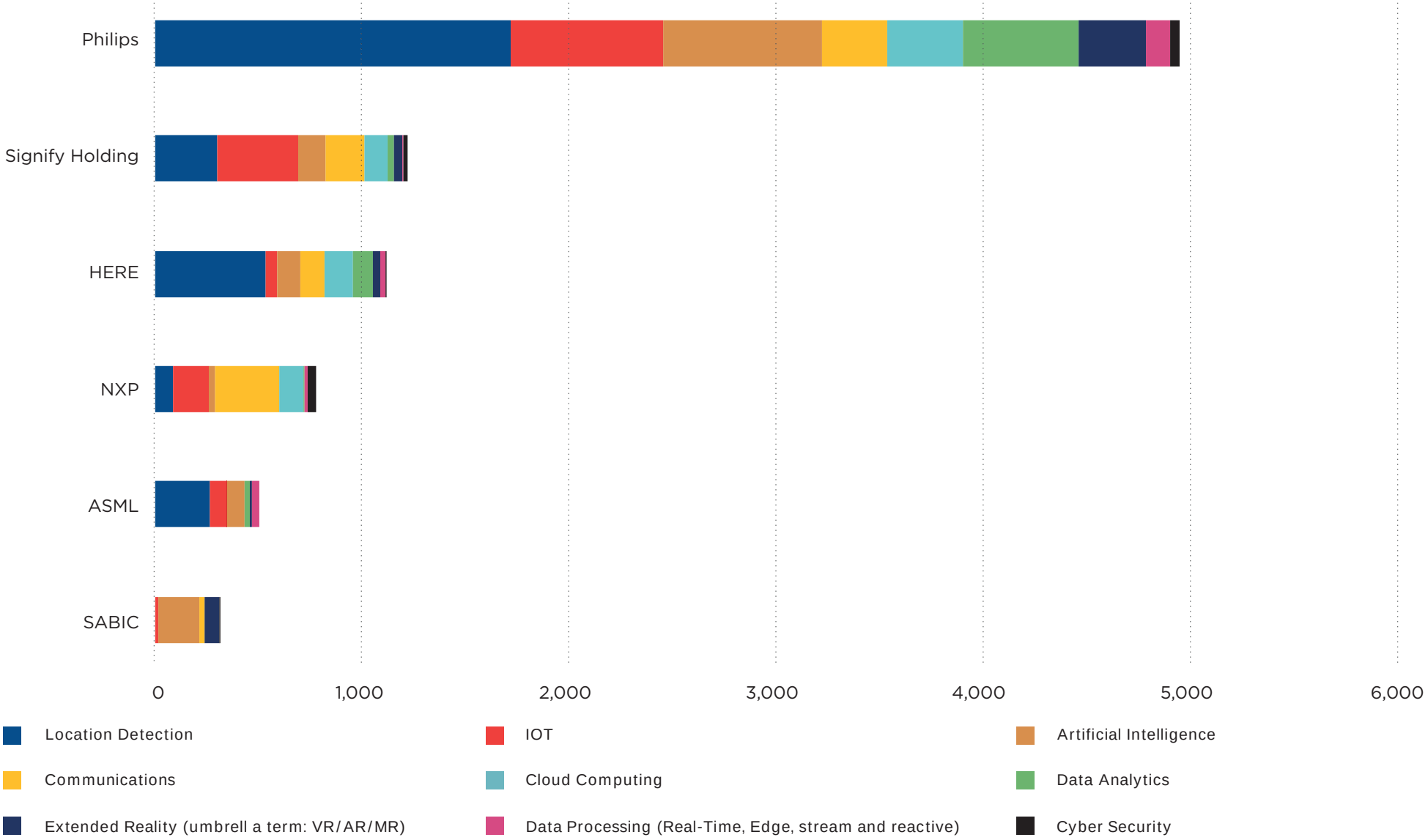
Synerscope

Forescout Technology

GTX Medical

Data Valley

Among the IT spearheads analyzed, six companies dominate the patent market in Brabant, accounting for over 90% of all patent applications in those IT spearheads in Brabant. The table below shows both these companies and the fields in which they are active.



BRAINPORT EINDHOVEN IS THE LEADING EUROPEAN CLUSTER FOR FOURTH INDUSTRIAL REVOLUTION (4IR) PATENTS

Recent studies by the EPO have demonstrated that Brabant's Eindhoven is the **leading European cluster for 4IR patents**. According to this study, the region specializes in **enabling technologies/software** and holds first place in **3D systems & smart healthcare solutions**.

Most 4IR patents in Eindhoven originate in the priority industries of High-Tech Systems and Materials (Smart industry and Smart Maintenance), Life Sciences & Health (Smart Health), smart mobility/Logistics and the application of smart technologies in the fields of the biobased economy, cities, chemistry, and agriculture and food.

Eindhoven is the leading European cluster for 4IR patents. According to the EPO study, the region specializes in enabling technologies/software and holds first place in 3D systems & smart healthcare solutions:

FOURTH INDUSTRIAL REVOLUTION PATENTS

European Ranking	Cluster	Share 4IR (2010-2018)
1	Eindhoven	1.2%
2	London	1.1%
3	Munich	1.1%
4	Stockholm	1%
5	Paris	1%
6	Stuttgart	0.9%

Source: European Patent Office (EPO) in 2020

4. UNIVERSITIES AND KNOWLEDGE INSTITUTES

A. IT & Data Science universities in brabant

The Netherlands has a large number of high quality universities and knowledge institutes and the country held fourth place in the 2019 Global Innovation Index of the World Intellectual Property Organization (WIPO) and is ranked tenth among countries with highest number of patent applications in proportion to GDP and population.

1. Eindhoven University of Technology (TU/e)

Facts and figures TU/e

- **121 hectares**
- **13,000+ students**
- **5,000 knowledge workers**
- **90 nationalities**
- **14 unique research labs**
- **100 companies and organizations**
- **700 apartments**
- **10 catering facilities**
- **70 sports facilities**

The Eindhoven University of Technology is a young university, founded in 1956 by industry, local government, and academia. Today, that spirit of collaboration is still at the heart of the university community. The university fosters an open culture where everyone feels free to exchange ideas and take initiatives.

Eindhoven University of Technology provides academic education that is driven by both fundamental and applied research. Its educational philosophy is based on personal attention and makes room for individual ambitions and talents. TU/e's research meets the highest international standards of quality and the work produced and pushes the boundaries of science. This puts TU/e at the forefront of various rapidly emerging areas of research.

Eindhoven University of Technology combines scientific curiosity with a hands-on approach. Fundamental knowledge enables the institution to design solutions for the highly complex problems of today and tomorrow. Its motto is: "We understand things by making them and we make things by understanding them'.

The TU/e Campus is in the center of one of the most powerful technology hubs in the world, Brainport Eindhoven. Globally, the university stands out when it comes to collaborating with advanced industries, as it has done with Royal Philips since its inception. Together with other institutions, TU/e forms a thriving ecosystem with one common aim – to improve quality of life through sustainable innovations.

EINDHOVEN UNIVERSITY OF TECHNOLOGY HAS TEN RESEARCH DEPARTMENTS AND FOCUSES ON TEN STRATEGIC RESEARCH AREAS

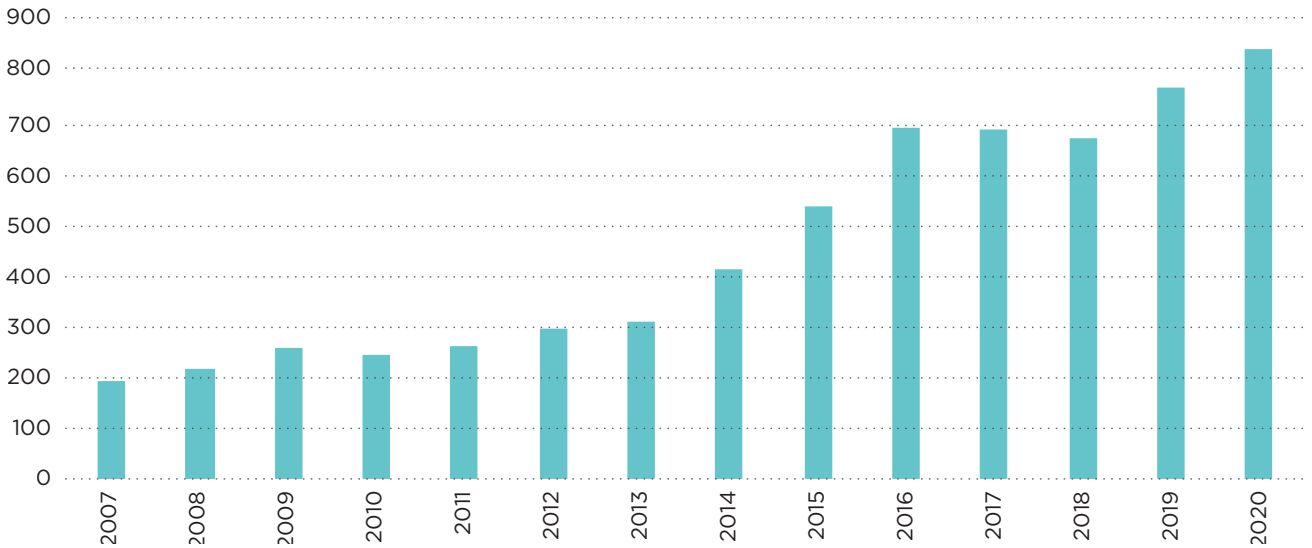
	TU/e has ten Research Departments:		TU/e has ten Strategic Research Areas:
I.	Biomedical Engineering	1.	Artificial Intelligence
II.	Built Environment	2.	Smart Mobility
III.	Electrical Engineering	3.	Energy
IV.	Industrial Design	4.	Engineering Health
V.	Industrial Engineering & Innovation Sciences	5.	Integrated Photonics
VI.	Chemical Engineering and Chemistry	6.	High-tech Systems
VII.	Applied Physics	7.	Robotics
VIII.	Mechanical Engineering	8.	Data Science
IX.	Mathematics and Computer Science	9.	Humans and Technology
X.	Eindhoven School of Education	10.	Smart Cities

All departments at the Eindhoven University of Technology and the fields they engage in are related to HTSM industries, semiconductors, medical technology, lighting, printing, data science, or new materials.

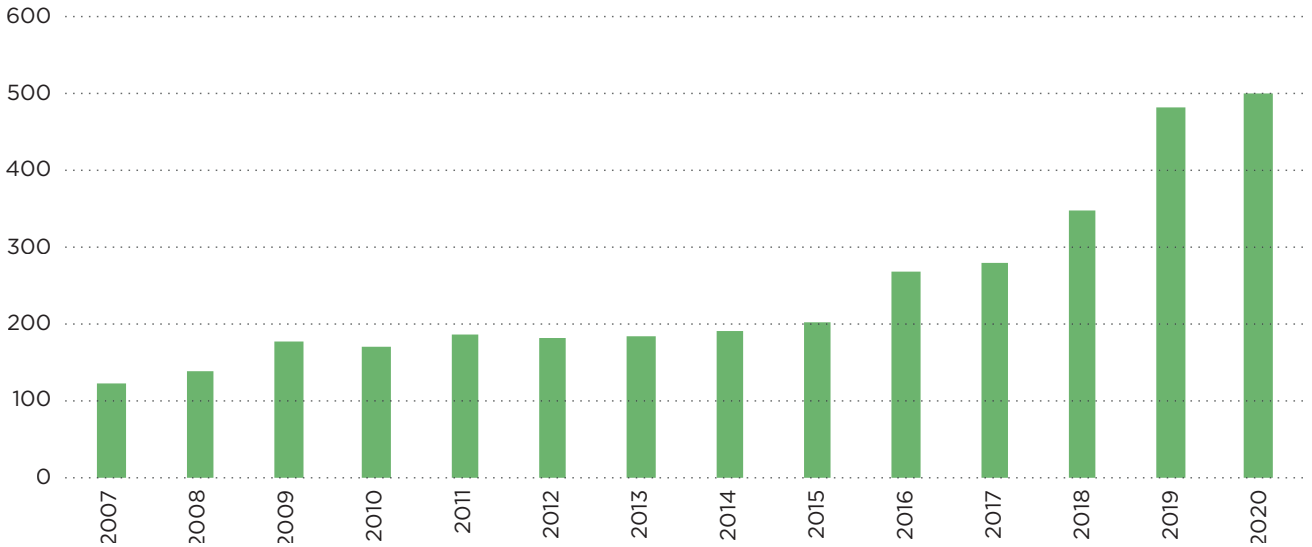
Source and more info: https://www.tue.nl/

IT STUDENTS AT THE EINDHOVEN UNIVERSITY OF TECHNOLOGY

New IT Students



Graduates



Source: CA-IT (2021) Expertise Center Digitization IT

IT-RELATED COURSES AT TU/E:

Eindhoven University of Technology	
Bachelor of Data Science (joint degree)	Master of Innovation Sciences
Bachelor of Computer Science and Engineering	Master of Systems and Control
Bachelor of Technical Informatics	Master of Industrial and Applied Mathematics
Bachelor of Technical Mathematics	Master of Human-Technology Interaction
Bachelor of Human-Technology Interaction	MasterTrack certificate in Artificial Intelligence Engineering Systems
Bachelor of Applied Mathematics	MasterTrack certificate in Data Science in Engineering
Bachelor of Automotive Technology	MasterTrack certificate in Connected World Technology
Bachelor of Electrical Engineering	MasterTrack certificate in Manufacturing Systems Engineering
Bachelor of Medical Sciences and Technology	MasterTrack certificate in Information Security Technology
Master of Artificial Intelligence Engineering Systems	MasterTrack certificate in Medical Imaging
Master of Data Science & Artificial Intelligence	MasterTrack certificate in Smart Mobility Data Science and Analytics
Master of Data Science and Entrepreneurship (joint degree)	PDEng in Data Science
Master of Business Information Systems	PDEng in Information and Communication Technology
Master of Embedded Systems	PDEng in Smart Building & Cities
Master of Automotive Technology	PDEng in Software Technology
Master of Computer Science and Engineering	PDEng in User System Interaction

Established in the 1950s, the TU/e has always had strong values: optimism, collaboration, and a dedication to society. These values have helped Brainport Region Eindhoven flourish and has resulted in the university being ranked in first place by the Times Higher Education Ranking for collaboration with industry. Fifteen percent of the TU/e's scientific publications are created in partnership with industry, and the university has the highest number of part-time professors who work in industry in the country.

Societal challenges on health, energy and smart mobility are the driving force for the TU/e. Its research institutes, the Eindhoven Artificial Intelligence Systems Institute (EAISI), the Eindhoven Institute for Renewable Energy Systems (EIRES), the Institute for Complex Molecular Systems (ICMS), and the Institute for Photonic Integration (IPI), Eindhoven Engine, and The Gate combine the strengths of the university with industry needs and government strategy. TU/e researchers play an important role in new products and companies in the Brainport Eindhoven area, in Brabant, and around the world.

TU/E RESEARCH GROUPS

There are a total of 90 research groups in the various departments, with the following ones being most relevant when it comes to IT:

Department of Mathematics and Computer Science:

Research Group	Research topic
Applied analysis	The Applied Analysis Group focuses on these mathematical disciplines and their application to the real world around us. This brings together many mathematical topics, such as differential equations, dynamical systems, variational calculus, functional analysis, geometry, and approximation theory.
Artificial intelligence	Research on apparently intelligent behavior by machines, distinct from human and animal intelligence.
Coding theory and cryptology	The group covers research in coding theory and cryptology. **Coding Theory:** This is the mathematical theory of encoding information in such a way that it becomes resistant to transmission errors. The main topics are the study of the properties of various codes (cyclic codes, BCH codes, MDS codes, algebraic geometric codes) and the construction of efficient decoding algorithms for these codes. **Cryptology:** This is the mathematical theory of protecting information against unauthorized access (privacy), determining if a message has been altered by a third party (integrity), adding a signature to an electronic document, and verifying the identity.
Data mining	The group is known for its contributions to the fields of predictive analytics, automation of machine learning and networked science, subgroup discovery and exceptional model mining, and similarity computations on complex data. Its research is inspired by theoretical computer science, systems development, and real-world applications of (big) data-driven discovery in healthcare, banking, energy, retail, telecom, and education, among other areas.
Database group	The Database (DB) group studies core engineering and foundational challenges in scalable and effective management of Big Data. Expertise within the group includes query language design and foundations, query optimization and evaluation, data analytics, and data integration.
Discrete algebra and geometry	This area of mathematics has become increasingly important in recent decades, in part due to the advent of computers and in part because of the recent ubiquity of large discrete (social, biological, ecological, etc.) networks. Discrete mathematics has many real-world applications in areas such as logistics, engineering, cryptography, computer algorithms, computer vision, and relational databases. Applications vary from finding an optimal railway schedule, securing your privacy in WhatsApp, or protecting your data on a memory device against physical damage.
Formal system analysis	The FSA group studies the foundations of software-controlled systems and develops languages and techniques for modelling and analyzing real-world, industrial-scale applications. Expertise in the group includes process algebras for reasoning about concurrent, timed, and probabilistic system behavior, SAT- and SMT-solvers, rewriting, and model checking technology.
Information systems, W&I	One of the foundations of computer science today is data. The main mission of the group is to bridge the gap between process science (BPM, WFM, formal methods, etc.) and data science.
Interconnected resource-aware intelligent systems	The Interconnected Resource-aware Intelligent Systems cluster addresses (distributed embedded) systems performance challenges in terms of timing behavior, dependability, programmability, reliability, robustness, scalability, accuracy, energy and data computation efficiency, and trustworthiness.
Mathematical image analysis	The Mathematical Image Analysis research group focuses on the development of new methodologies and algorithms for the representation and analysis of complex imaging data (`big images') for healthcare applications.

Scientific computing	Scientific computing is a fast-growing, highly interdisciplinary field that brings together methods from numerical analysis, high-performance computing, and various application fields. It is the area of research that provides better simulation tools aimed at many different applications.
Software engineering and technology - W	The Software Engineering and Technology (SET) Group researches software engineering, with a strong focus on theory, methods, and tools for maintaining consistency between models and code. SET investigations are not limited to recent software development phenomena, but also focus on various other topics such as software migration, re-engineering, and reuse.
Stochastic operations research	The SOR group researches the field of queueing theory and analysis of random walks and higher-dimensional Markov processes. A key aim is to develop analytic, probabilistic, algorithmic, and asymptotic methods, with an emphasis on asymptotic laws and scaling limits for large-scale critical systems. While fundamental and methodological in nature, the research is deeply inspired by applications in computer-communications, logistics, and service operations, but also biological systems, particle interactions, and social networks.
Visualization	The Visualization research group develops new methods to present large data collections in new insightful ways. The human eye, human interaction, and design are key to this research.
Advanced network management and control	This group studies the impact of emerging applications on the network and the effects that network impairments have on services. The main focus is on cognitive Internet of Things communications.

DEPARTMENT OF ELECTRICAL ENGINEERING

Research Group	Research topic
Center for Wireless Technology Eindhoven (CWTE)	CWTE explores boundaries and new applications of wireless technology by creating a coherent, integrated approach to wireless systems, from the propagation of radio waves up to and including optical and wireless access networks.
Center for Care & Cure Technology Eindhoven (C3TE)	The Center for Care & Cure Technology Eindhoven (C3TE) focuses on multi-disciplinary research in the fields of care and cure. By linking the technological strengths of electrical engineering and applied physics to clinical partners and industry players, collective knowledge is expanded, leading to the sustainable improvement of healthcare.
Signal Processing Systems	The Signal Processing Systems (SPS) group studies theories and techniques to extract meaningful information from signals, images, and multivariate data sets.
Control systems	Research on dynamic modelling and model-based control of complex dynamic systems.
Electromagnetics	Enabling "electromagnetic engineering" by developing new modeling strategies for analysis and synthesis of a range of applications, such as antenna systems, medical electromagnetic stimulation, and metrology used in semiconductor manufacturing equipment. In order to do so, this groups develops new facilities for experimental research in the field of antennas and wireless communications systems.
Electronic systems	This group creates constructive design trajectories for electronic systems that lead to high-quality, cost-effective systems with predictable properties (functionality, timing, reliability, power dissipation, and cost).
Photonic integration	The goal is to provide major contributions to photonic integration and associated applications, with a particular focus on indium phosphide technology.
Advanced network management and control	Research on the impact of emerging applications on the network and the effects that network impairments have on services. Our main focus is on cognitive Internet of Things communications.
Electro-Optical Communication	The group focuses on the following research goal: virtually unlimited bandwidth without congestion, anytime, anywhere, for any service.

Source and more info: https://www.tue.nl/

DEPARTMENT OF INDUSTRIAL ENGINEERING & INNOVATION SCIENCES

Research Group	Research topic
Human technology interaction	The Human-Technology Interaction (HTI) group analyzes people's interaction with technology, with the aim of better understanding and improving the relationship between technology and its users.
Information systems IE&IS	The Information Systems group studies tools and techniques that allow information systems to be used in the best possible way, getting the most value out of them. The group focuses on the following areas of application: smart industry, healthcare, mobility, transportation and logistics, and the services industry. Research areas: business engineering, business intelligence and process engineering.

DEPARTMENT OF BIOMEDICAL ENGINEERING

Research Group	Research topic
Medical image analysis	Developing methods and applications for medical imaging in order to improve clinical care. The group contributes to this rapidly growing field by developing new concepts for medical image analysis as well as applications that support clinicians in their decision-making, ultimately aiming for safer and better care. It investigates image analysis on methodological topics such as registration, quantification, crowdsourcing, and machine learning.

DEPARTMENT OF THE BUILT ENVIRONMENT

Research Group	Research topic
Information systems in the built environment	The ISBE Group performs research and education in the field of information systems used for the engineering and management of the built environment, in which they are embedded. Key research and education topics, with a special focus on smart cities, are: urban management, building information management and energy-neutral cities.

A SELECTION OF RELEVANT RESEARCH LABS AT TU/E

The Eindhoven University of Technology is home to a lively community where knowledge and brilliant minds from the campus and beyond meet and work together on pioneering research on societal challenges and issues. In order to conduct this groundbreaking research, attract outstanding scientific talent, and train new generations of engineers, the campus is home to state-of-the-art research labs and facilities, of which some are unique in the Netherlands and even the world.

SIGNIFICANT RESEARCH LABS FOR IT INCLUDE:

Research Lab	Focus:
Artificial Intelligence and Data Engineering lab	The lab focuses on research on AI and data in the TU/e areas of application.
IoT Lab	Security experiments involving various IoT devices.
BlackHat's lab	The B-LAB provides a powerful infrastructure for experimenting with malware, vulnerabilities, and exploits. The infrastructure is setup to assure a high degree of isolation from the network environment while allowing remote collaboration with affiliate institutions. The lab provides access to APT malware platforms, exploits and exploit kits traded in the underground, and nation-grade vulnerability exploits.
Security Operation Center (SOC)	The SOC is a centralized unit that monitors the security state of a computer network. In the lab, the initial scope of the SOC includes two areas to monitor: the IT network of the department (office) and the cyber-physical sensors network of the university (building/security).
Center for Wireless Technology	The CWT/e facilitates research on wireless systems and antennas, raising the Internet of Things to a higher level.
Digital Twin lab	The Digital Twin lab supports experiments in the area of digital twins, in its three areas of application of high-tech systems, health, and mobility. This typically involves modelling real-world situations and creating data interfaces between the real-world context and model. The Digital Twin lab provides tools such as virtual reality (VR) and augmented reality (AR) to allow deeper interaction with the virtual models.
Geometry Lab	The Geometry Lab is an initiative of the ALGA cluster, focusing on researching applications of computational geometry. The lab provides a space to experiment with a virtual reality setup and a large number of e-puck2 robots.
Atlas Living Lab	In the Atlas Living Lab members conduct and partake in research into intelligent lighting and climate systems. This research contributes significantly to a sustainable and comfortable working environment. The Atlas Living Lab is a leading laboratory for scientific research in the middle of a functioning office space. Two floors of the building are furnished as a living lab. **The Atlas Living Lab is the largest indoor living lab in Europe.** *The strategic fields of energy, data science and the Intelligent Lighting Institute use the Atlas Living Lab for research into energy-saving and adaptive intelligent lighting with a focus on their impact on human behavior and well-being.*

IT & DATA SCIENCE STUDENT TEAMS AT THE EINDHOVEN UNIVERSITY OF TECHNOLOGY

TU/e is a breeding ground for young engineers tackling societal challenges. They do this in projects that combine education, innovation, and entrepreneurship funded by TU/e and our sponsors. Student teams include:

SERPENTINE AI

Serpentine is an association focused on artificial intelligence. This team is based in Eindhoven and connects engineers, students, researchers, and industry players. The team develops state-of-the-art algorithms to participate in AI e-sports competitions. With a mission to prepare engineers in all disciplines for a future involving artificial intelligence, the team is supported by various engineering companies and institutes. Their support allows Serpentine to continue to connect academics, students, and industry.

Source and more info: https://serpentine.ai

FruitPunch AI

FruitPunch AI is the global AI for good community, founded in Eindhoven, that works to solve humanity's greatest challenges. By conducting AI for Good projects and challenges like AI for Wildlife, FruitPunch AI is educating a generation of AI engineers in the ethical and sustainable application of AI. For participants, FruitPunch AI provides free AI education, a global community of peers and real-world experience. Partners receive unbiased and future-proof solutions in line with the sustainable development goals, experienced AI talent, corporate education and, of course, a fair share of good press.

In its AI for Good projects, FruitPunch AI takes on humanity's greatest challenges through the application of artificial intelligence – on the basis of the belief that AI is the best force multiplier and thus essential for solving the sustainable development goals set by the United Nations, in world where resources are scarce. FruitPunch AI has a problem-first mindset, which means that although it believes that DS plays a central role in many projects, it works in teams with people from all scientific fields.
The following programs are in place:

- AI for Wildlife
- AI for Health
- AI for Food

Source and more info: https://fruitpunch.ai/

HART (Human Augmentation Research & Technology)

The way we experience the world is limited by the sensory receptors we are born with. HART envisions a future where the constraints of human biology disappear and new ways of experiencing the world arise by giving people the freedom of experience. The human brain is a black box that specializes in deciphering patterns, and by translating parts of reality into consistent patterns, the brain can learn to unlock new ways of experiencing reality.

Equipped with advanced sensors, state-of-the-art artificial intelligence, and a knowledge of the human brain and body, the team strives to create a platform that will allow anybody to translate parts of reality into consistent patterns that are comprehendible by the human brain. This will open the full realm of human experience and lead to the question: "how would you like to experience the world"?

The team aims to enable us to interpret multiple languages through haptic feedback and to create a unified language of touch. It believes this technology will be a life-changer for deaf people and visitors to a foreign country.

- Sensors pick up data: Microphone picks up speech from the environment.
- AI finds patterns in data: Speech is processed, translated, and mapped into recognizable patterns.
- Tactile communication with the brain: Constructed patterns are communicated with haptic feedback.
- Brain learns and deciphers patterns: After a short period of learning, your brain learns to recognize the patterns and, therefore, speech.

Source and more info: https://teamhart.nl

OTHER STUDENT TEAMS THAT ARE USING AI IN THEIR PROJECTS:

Blue Jay

The team's mission is to extend the boundaries of intelligent systems through innovation and user-centered design, developing drones capable of assisting people in indoor settings in a manner that is safe, autonomous, interactive, and helpful.

Source and more info: https://www.bluejayeindhoven.nl

Solar Team Eindhoven

Works on sustainable mobility by developing a comfortable, self-driving family car that maximizes the use of solar energy by efficiently using energy for itself and by sharing it with others. Three-time winner of the Bridgestone World Solar Challenge in Australia.

Source and more info: https://solarteameindhoven.nl

Tech United

Tech United is a team of students, PhD graduates, and employees of the Eindhoven University of Technology involved in the development of robotics. The team competes with autonomous soccer robots and autonomous service robots. It won the 2019 world championship and many other championships.

Source and more info: https://www.techunited.nl

University Racing Eindhoven

URE builds revolutionary electric Formula-style race cars to compete in the annual Formula Student competition in both the electric and autonomous racing classes.

Source and more info: https://www.universityracing.nl

2. JHERONIMUS ACADEMY OF DATA SCIENCE (JADS)

The Jheronimus Academy of Data Science (JADS) is a unique concept in the Netherlands, which allows graduates to study, research and apply data science at three different Data Science Centers (TU Eindhoven, Tilburg University, and Mariënburg Campus, Den Bosch) as part of the PDEng program and to incorporate what they learn into existing ecosystems. The mission of JADS is to understand and further the value of data for solving complex societal and business challenges, with the academy serving as a linchpin between industry and the applied data science research conducted throughout JADS. The AgriFood industry is a Priority Industry to JADS, given that linking AgriFood to high tech by means of data communication, big data processing and artificial intelligence (AI) is one of society's challenges when it comes to sustainably feeding the world's growing population.

The Data Science and Entrepreneurship Graduate School turns out entrepreneurial and innovative data scientists who are just as good at performing cutting-edge scientific research as they are at applying it to the most pressing societal and business challenges. These graduates learn to operate in a collaborative ecosystem, fostering a stream of new scalable (or exponential) business models in Brabant and beyond.

The current JADS student body numbers 1,500-2,000, scattered across a range of programs and three research centers.

JADS offers the following programs for students:

Programs	
Joint Bachelor of Program Data Science	The Data Science bachelor's degree is a joint undergraduate program offered by Tilburg University and the Eindhoven University of Technology. The degree is taught in English, and the BSc awarded is a stepping-stone to turning Big Data into value-added solutions for technology, industry, government, and society.
Master of Programs Data Science	JADS offers several data science master's programs at the Mariënburg Campus in 's- Hertogenbosch, the Eindhoven University of Technology, and Tilburg University. Each program focuses on a different data science application or area of expertise.
PDEng Program in Data Science	A PhD can also be performed at JADS, which sees graduates involved in cutting-edge research at any one of the three campuses: TU/e, Tilburg University or JADS, depending on the focus of the research.
PhD Programs in Data Science	A PhD can also be performed at JADS, which sees graduates involved in cutting-edge research at any one of the three campuses: TU/e, Tilburg University or JADS, depending on the focus of the research.

Source and more info: https://www.jads.nl/dsc-den-bosch.html

THE RESEARCH AREAS OF APPLICATION:

Social & Digital Entrepreneurship

The field of Social and Digital Entrepreneurship, which is often called Data Science and Artificial Intelligence for the Good, refers to the digital knowledge and skillset required to develop and run enterprises whose primary objective is to contribute to solving societally relevant problems. These issues typically range from No Poverty and Zero Hunger through to Peace, Justice, and Strong Institutions. They are generally known as the sustainable development goals that were introduced in 2015 by the United Nations as the blueprint for a better and more sustainable future for all.

AgriFood and Nature

Both the world population and food consumption are rising rapidly. The current system for producing, processing, and trading food is past its expiration date, and we need a transition from the current unsustainable food system to a healthy, circular, and resource-efficient paradigm. In order to continue to provide sustainable food for the growing world population, something must change and must change now. How do we ensure that there is enough food to feed the world by 2050? In the coming decades, the eyes of the world will be on the AgriFood sector. Technological developments, in which data science plays a key role, can make an important contribution to the transition of the industry. Data is an important catalyst for this and, at the same time, offers opportunities for new, disruptive business models in that industry.

The use of data is a key ingredient for the AgriFood sector to boost both productivity and sustainability and to remain competitive. The step from data to information for business is a big and very valuable one. Many companies recognize the importance, usefulness, and necessity of it, but still experience difficulties with its actual implementation for their own organization or in terms of using data effectively to connect the food value chain.

- JADS links up and integrates research, education, and business-focused activities within the AgriFood & Data program.
- JADS develops translational data science expertise and educates talent in the field of data fusion and smart data analytics for the fields of AgriFood and Nature.
- JADS develops impact-driven projects together with business.

Crime & Safety

Data science is becoming increasingly valuable, both in respect of detecting and preventing crime, as well as in enhancing the safety of our society. Computers and algorithms compare and contrast information and perform complex calculations at lightning speed. In the Department of Data Science in Crime & Safety data science is used to contribute to a safer society, with data science investigated and applies in a fair and responsible manner.

Example of JADS Contribution:

Is there anything more important than contributing to a safe society? The Department of Data Science in Crime & Safety at JADS works with the police and prosecution services to combat organized crime by combining different sources of data in a responsible manner. The department also works with the banking industry, where data science can help to identify suspicious transactions in an early stage, as well as the Dutch Fiscal Information and Investigation Service, using smart imaging to extract images of contraband from huge amounts of data.

THE JADS DISCIPLINES:

1. Data Analytics: The Data Analytics Unit (DAU) at JADS combines expertise in the domains of causal inference, social network analysis, AI, and, in particular, machine learning with the goal of explaining the dynamics of complex phenomena.
2. Data Governance: Data engineering for studying sensor networks and machine learning pipelines.
3. Data Entrepreneurship: Using machine learning and network analysis to study interactions in meetings, entrepreneurial pitches, social influence, interaction norms, and routines.

THE JADS SME DATA LAB

The JADS SME Data Lab helps companies create value through data by conducting short-term projects with professional and student data scientists. The students receive professional guidance from experienced professionals and scientists. Wherever a student hits a stumbling block, the JADS lab will always ensure that the project reaches completion.

The lab works together with its clients to define a data project with a concrete outcome. Preference is given to projects that deliver immediate savings or increased profits. Sometimes the client's aims extend beyond a single project, in which case we examine how a series of projects might produce the intended outcome.

A student spends about 60 to 80 hours on a project over six to ten weeks (depending on exam periods and other obligations). The JADS SME Data Lab charges a fixed price of 2,750 euros per project, part of which goes to the student involved in the form of remuneration.

FUNDAMENTAL LABS

The fundamental labs focus primarily on establishing and advancing the scientific side of data science, leading to discoveries, theories, and new technologies for multidisciplinary applications.

Programs	Activity
Dynamic Organizational Networks	The Innovative Data Services Lab focuses on the transition of product-oriented firms to becoming solution-providers through the application of data. The lab conducts research and supports companies through educational programs for executives and tailored solutions for businesses.
Recommender Lab	In the Recommender Lab the research focuses on how decisions can be supported by recommender systems. It includes domains such as movies, music, health-related decisions, and energy-saving measures.
Computational Personalization	The focus of the Computational Personalization Lab is on statistical and machine learning methods for treatment personalization in healthcare and other fields. The lab tries to find the "right treatment for the right person" by developing and analyzing sequential allocation policies and building software to deploy these policies in field experiments.
Jheronimus Academy Data Engineering (JADE) Lab	Industry-level Big Data tech demands a systematic study, development, and evaluation of methods, techniques, and tools catering to big data-intensive software and data engineering. The JADE lab will serve the JADS and EU research community in achieving excellence in this field by creating synergies with the most renowned academic researchers and practitioners from both JADS' parent universities, industry, and other universities.
Digital Business Models & Ecosystems	In the DBM Lab the research focuses on how to translate data and the outcomes of data mining and visualization techniques into new business opportunities.
Ambitious Digital Entrepreneurship	The Ambitious Digital Entrepreneurship Lab is focused on teaching and conducting research into the intersections where data science and entrepreneurs meet in the quest for creating value with big data and new technologies.

Source: https://www.jads.nl/dsc-den-bosch.html

JADS RESEARCH PROJECTS

Researchers at JADS participate in several national and international projects that aim to contribute to major societal challenges like health, food security, smart transport, and secure societies. Together with companies, public agencies, NGOs, and other knowledge institutes, the researchers work on solutions by using data.

Examples of research projects include:

- **FARM-IT!:** The FARM IT! project aims to foster the use of data in the AgriFood sector in order to realize innovations that achieve greater precision and efficiency.

- **Werkinzicht" (Work Insight):** this project aims to stimulate cross-border mobility of job-seekers in the southern region of the Netherlands and Flanders in northern Belgium, using innovative user-friendly solutions based on the harmonization and visualization of data.

- **Sodalite:** JADS researchers are working on increasing the simplicity, design, and runtime effectiveness of pattern-based data-intensive modelling applications and software-defined infrastructures in dynamic heterogeneous execution environments. This will lead to improvements in manageability, collaborations, and time-to-market.

- **RADON:** RADON aims to create a DevOps framework producing and managing microservices-based applications that can optimally exploit serverless computing technologies. These applications will include fine-grained and independently deployable microservices that can efficiently exploit FaaS and container technologies. The end-goal is to broaden the adoption of serverless computing technologies within the European software industry.

- **SPEED:** aims to build an ecosystem for smart port app development in Belgium, France, the Netherlands, and the UK, bridging the gap between the worlds of European ports and the nascent data science, IoT market.

- **Anita:** ANITA (such as advanced tooling for fighting illegal online trafficking) aims to improve the investigation capabilities of LEAs (law enforcement agencies) by delivering a set of tools and techniques for efficiently addressing the illegal online trafficking of counterfeit/fake medicines, NPS, drugs, and weapons.

- **Di-Plast** - Digital Circular Economy for the Plastics Industry: the use of recycled plastic material (rPM) in NWE is homogeneously low. In packaging and building, the greatest plastics-consumers, only 8% (787 KT) and 18% (978 KT) respectively is recyclable (Plastics Europe 2016). Impeding factors are: unclear recycling quality, unstable supply, and insufficient awareness (EuPC 2017).

3. Tilburg University

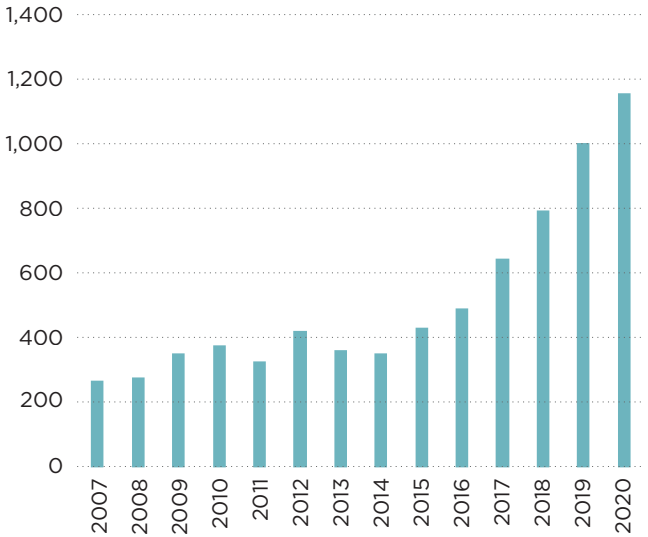
Tilburg University is made up of five schools: the Tilburg School of Economics & Management, Tilburg Law School, Tilburg School of Social and Behavioral Sciences, Tilburg School of Humanities and Digital Sciences (University College Tilburg), and Tilburg School of Catholic Theology.

Facts and figures Tilburg University

- **73 bachelor's, master's, and other courses**
- **19,334 students**
- **35 programs offered in English**
- **Over 78,000 alumni since 1927, with over 8,900 international graduates**
- **3,711 international students**
- **From 132 different nationalities**
- **1,500 professional and educational staff**

IT STUDENTS AT TILBURG UNIVERSITY:

New IT Students



Graduates

Source: CA-IT (2021) Expertise Center Digitization IT

IT-RELATED COURSES AT TILBURG UNIVERSITY:

Tilburg University	
Bachelor of Data Science (joint degree)	Master of Econometrics and Mathematical Economics
Bachelor of Cognitive Science and Artificial Intelligence	Master of Cognitive Science and Artificial Intelligence
Master of Data Science and Society	Master of Economics: Data Science
Master of Information Management	Master of Data Science and Entrepreneurship (Joint Degree)
Master of Business Analytics and Operations Research	Master of Data and Digital Society
Master of Marketing Analytics	Master of Methods and Statistics track (research master's degree)

A STRONG FOCUS ON AI AT TILBURG UNIVERSITY

AI plays a role in providing better and more efficient responses to major issues. Tilburg University's strength is that it illuminates these issues from various angles. The university combines expertise in AI with expertise in people and society.

"We are active in fundamental AI. We have a large department that works on AI algorithms and has several programs that attract many students. We also work on AI through other disciplines and perspectives, in schools such as the Tilburg School of Economics and Management (TiSEM), the Tilburg School of Social and Behavioral Sciences (TSB), and Tilburg Law School (TLS). There are fantastic researchers in these schools who, from their own perspective, all create a close and direct connection to the big social AI issues."
- Boudewijn Haverkort, Dean and full professor at the Tilburg School of Humanities and Digital Sciences (TSHD)

School	Program	Type	#students*
TLS	Law and Technology (1 yr)	Master Program	200
	Data Science	Bachelor Program	175
TSHD	Cognitive Science & AI	Bachelor Program	700
	Data Science & Society (1 yr)	Master Program	250
	Cognitive Science & AI (2 yr)	Master Program	300
TISEM	Data Science & Entrepreneurship (2 yr)	Master Program	150
	Information Management (1 yr)	Master Program	150

* academic year 2019-2020

RESEARCH INSTITUTES AND GROUPS AT TILBURG UNIVERSITY

Tilburg University is home to 38 research groups and institutes. Those with a focus on IT are the Data Science Center Tilburg (DSC/t), the Institute for Data Collection and Research (CentERdata) and the Tilburg University Artificial Intelligence Special Interest Group (TAISIG), the Tilburg Center for Cognition and Communication, and the Tilburg Institute for Law, Technology, and Society (TILT)

DATA SCIENCE CENTER TILBURG

The Data Science Center Tilburg (DSC/t) brings together Tilburg University's scientific expertise in economics, management, law, social sciences, behavioral sciences, and the humanities to develop and apply data science.
Data science is a multidisciplinary scientific field, with a major role played by computer science and mathematical and statistical techniques as well as human-technology interaction, social sciences, and legal and ethical aspects. The Data Science Center Tilburg is unique in that it combines these areas of expertise from Tilburg University's various schools. Tilburg University's research is based on a strong tradition of quantitative and technical research skills. In the DSC/t the extensive knowledge in applied data science is combined with a high level of expertise in communications as well as in values, ethics, and regulatory and legal implications.

Knowledge area	Subjects
1. People	• Human-technology interaction (HTI) • Artificial intelligence
2. Rules	• Legal • Ethical • Philosophy of science (including research methods)
3. Methods	• Mathematics • Statistics • Research methods • Web science • Automated software services • Distributed (enterprise) computing • Database systems • Data visualization
4. Value	• Data entrepreneurship • Corporate entrepreneurship • Creativity and innovation • Open innovation

The following application domains are defined:

1. Consumer behavior
2. Smart industries ("Industry 4.0")
3. Health analytics
4. Human capital and labor market
5. Smart cities
6. Finance institutions
7. Legal analytics

Source:
www.tilburguniversity.edu/research/institutes-and-research-groups/data-science-center

TILBURG UNIVERSITY ARTIFICIAL INTELLIGENCE SPECIAL INTEREST GROUP

A wide variety of scientists are involved in AI at Tilburg University. The TAISIG pools and strengthens AI activities and accelerates the development of new research proposals and grant applications. The TAISIG is active in regional and national networks.

Areas of application of the AI Special Interest Group:

- **Health and care:** medical imaging, patient analysis, personalized care
- **Business and services:** business process optimization, fin-tech, market analysis
- **Education and learning:** learning analytics, virtual environments, on-line learning
- **Industry and transportation:** preventive maintenance, logistics, regulations
- **Society and government:** labor market analysis, livable cities, social legislation, decision support
- **Media and behavior:** online platforms, digital cultures, behavioral influencing

The TAISIG is divided into three clusters: AI tools and methods, ELSA, and AI applications. AI tools and methods focuses on fundamental AI, ELSA (ethical, legal and societal aspects of AI) on the required preconditions and impact of AI on society, and AI applications deals with applications.

AI tools and methods

The primary focus in this cluster is on natural language processing, machine learning (including deep learning), agents and robotics, decision-making, and computer vision.

ELSA

What problems do entrepreneurs encounter when they want to apply AI? What difficulties do municipalities, regulators, and policymakers experience in establishing and enforcing policies? These are just some of the questions that this cluster answers. It links scientific knowledge and expertise in AI, law, ethics, sociology, and psychology to the AI issues that society is confronted with.

AI applications

Thanks to artificial intelligence, it is possible to find answers to social issues faster, better, and more efficiently, based on data. But what does one then do with those answers? Without applications, incredible solutions will forever be stuck in the lab, which is why AI applications is such an important part of the TAISIG.

TILBURG CENTER FOR COGNITION AND COMMUNICATION

The Tilburg Center for Cognition and Communication (TiCC) provides answers to the questions of how people communicate with each other and how computer systems can be taught to communicate with us. The center explores the cognitive and social aspects of human communication through a multidisciplinary and multi-method approach, combining carefully designed experiments with survey methods, corpus analyses, computational modelling, and digital ethnographic methods. Core research topics include communication and technology, cross-cultural communication, information visualization, language production and understanding, non-verbal communication, and organizational communication.

The center collaborates with a broad and international range of universities and research centers as well as companies and non-profit organizations.

An example of a research project conducted by the center is: *In cooperation with a consortium of European universities and companies, researchers at the TiCC are developing a social robot that is designed to interact naturally with young children to help them learn English or Dutch.*

TILBURG INSTITUTE FOR LAW, TECHNOLOGY, AND SOCIETY (TILT)

The Tilburg Institute for Law, Technology, and Society (TILT) is a top player in the field of technology regulation and its normative implications. The center conducts research into the legal and social implications of various emerging technologies, such as IT, bio and nanotechnology, neurotechnology, and robotics. A key feature of the institute's research program is the interaction between legal, technological, and social perspectives.

CENTERDATA – INSTITUTE FOR DATA COLLECTION AND RESEARCH

CentERdata is a research institute located on the campus of Tilburg University. The institute supports and contributes to scientific, social, and policy-relevant research. The institute performs assignments for the academic community, government, and businesses, and its mission is to respond to research questions concerning people and society. CentERdata has extensive experience in developing software tools to support panel-based and other research, ranging from software tools for the coordination of the translation process for multilingual (international) questionnaires and large-scale fieldwork to the management of online panels and the dissemination of data and metadata.

CentERdata focuses on the techniques of and applications for big data. The institute uses machine learning, data mining and visualization techniques, creating new insights and value using different types of data.

4. Fontys University of Applied Sciences

The Fontys University of Applied Sciences has campuses in Eindhoven, Tilburg, Den Bosch, Helmond, and Veghel and focuses on five research topics:

- High-tech Systems & Materials
- Smart Society
- Health
- Learning Society
- Creative Economy

Fontys is the largest university of applied sciences in the southern Netherlands. Its mission is to provide inspiring, challenging, and outstanding higher vocational education and to conduct practical research that is truly meaningful to society. Education and research at Fontys are directly in line with the current and future demands and needs of students, the professional arena, and (regional) society.

FONTYS FACTS AND FIGURES

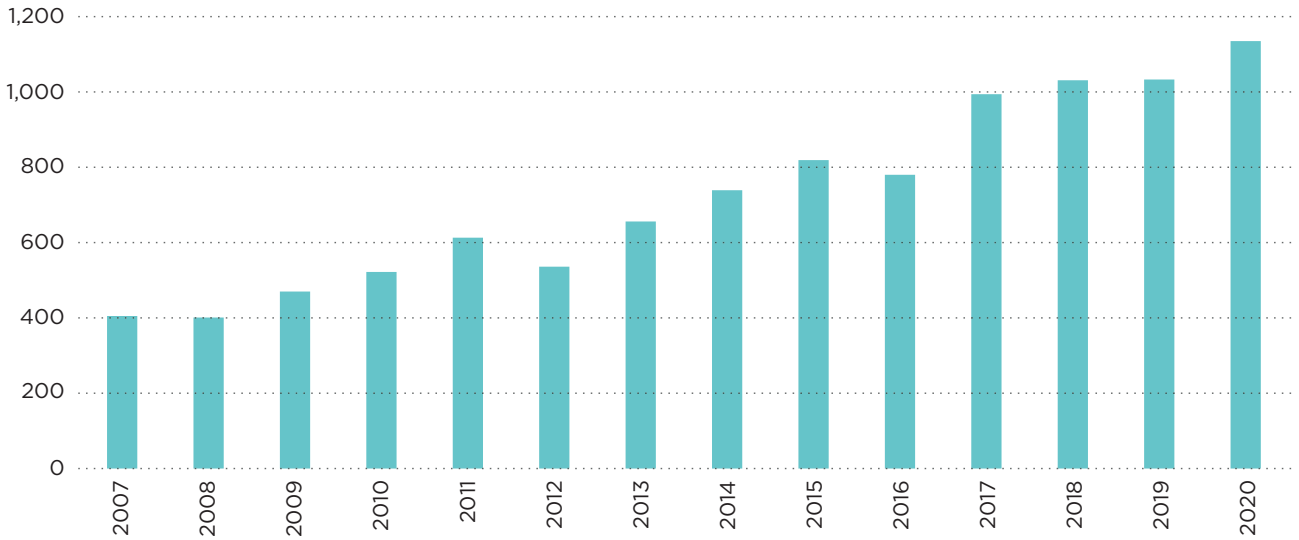
- 477 bachelor's, master's, and other courses
- 44,320 students
- 34 programs in English
- 7,697 graduates a year
- 5,200 international students
- From 100 different countries
- 4,938 professional and educational staff

EMBEDDED IN KNOWLEDGE REGIONS

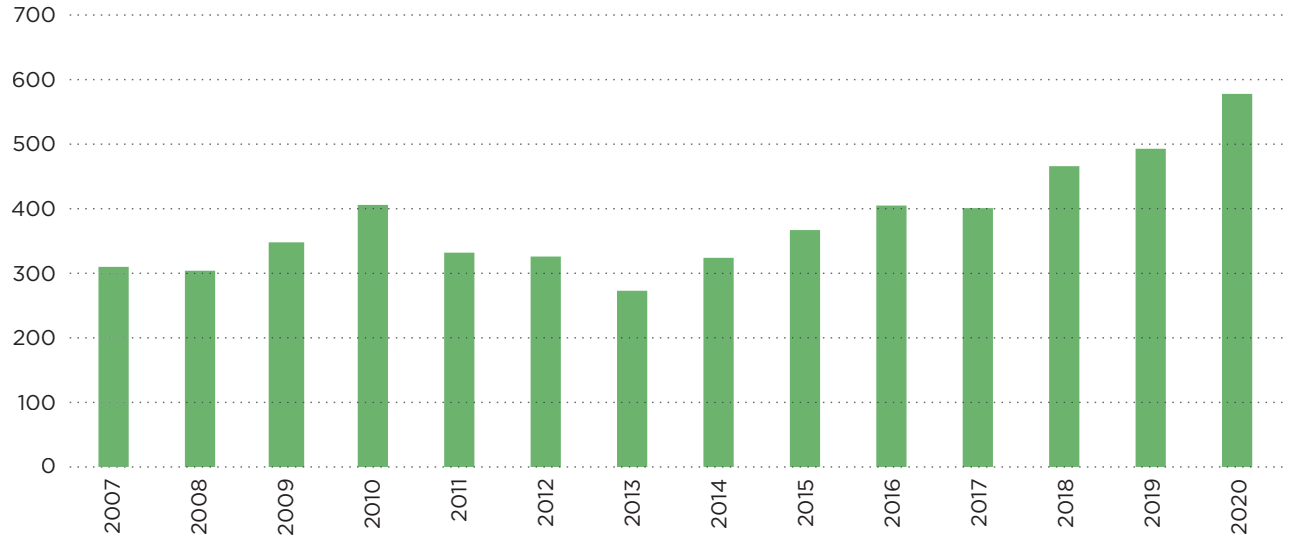
Fontys is embedded in the knowledge-intensive regions of the southern Netherlands, Brainport Region Eindhoven, Greenport Venlo/KennisAs Limburg, and Midpoint Brabant. The demand for highly qualified people in these regions is immense, and it is growing all the time. A number of human capital agendas have been formulated to this end, which Fontys has helped to develop. Together with fellow institutions, companies, and industry, Fontys has developed living labs, professional workshops, centers of expertise, and other facilities. Students, lecturers, and researchers from a range of disciplines work together with industry professionals.

IT STUDENTS AT THE FONTYS UNIVERSITY OF APPLIED SCIENCES:

New IT Students



Graduates



Source: CA-IT (2021) Expertise Center Digitization IT

IT-RELATED COURSES AT THE FONTYS UNIVERSITY OF APPLIED SCIENCES:

UAS Fontys
Bachelor of Automotive Engineering
Bachelor of IT
Bachelor of Information Technology – Software
Engineering and Business Informatics
Bachelor of Mechatronics
Bachelor of Applied mathematics
Associate degree in IT

The university has created six Centers of Expertise:

- Automotive (ace)
- Big Data
- Circular Transition
- High-tech Systems and Materials (HTSM)
- Knowledge DC Logistics
- The Education Engineers

RESEARCH CENTERS AT THE FONTYS UNIVERSITY OF APPLIED SCIENCES

The following research centers are relevant to the IT and Data science sector:

- **Centre of Expertise Big Data**
  At the Centre of Expertise Big Data, Fontys focuses on adding value to extensive, complex, and dynamic collections of data.
  The Expertise Center Big Data is concerned with the way in which big data is treated. This is best done through a process involving a specific structure consisting of a fixed chain of steps. The center also works on the tools required to properly execute the individual steps.

  The Big Data Centre of Expertise collects knowledge on big data from science, the professional world, and government and processes it in state-of-the-art educational programs. It employs the following approaches:

  a. bridging the gap between research, professional practice, and education
  b. initiating and conducting practice-oriented research
  c. improving the quality of existing education in the field of big data.

- **Big Data Lab**
  The Big Data Lab occupies an important place within Fontys research and education. The Big Data lab is a meeting place for data-driven service innovation. In multidisciplinary projects, the lab brings together knowledge on big data, IT, and specific domains.
  This allows the Big Data Lab to provide a practice-oriented learning environment for students, teachers, and professionals. The lab is also available for companies and organizations and for conducting research and high-quality experiments with large data sets.

Source: https://fontys.nl/Onderzoek/Expertisecentra-1/Big-Data-2/Experti

- **Fontys IT InnovationLab**
  The Fontys IT InnovationLab is an open innovation environment that has been operational since September 2018 and is located in the Strijp-T Innovation District in Eindhoven. In the very heart of the region, education, research, and work are intertwined and focus on IT innovation. Various research groups in the fields of Big Data, AI, blockchain and interaction design are housed in the 4000 m2 TQ building. A range of innovation partners work with 600 junior IT researchers (students) and 50 senior researchers on a wide range of issues to accelerate the digital transformation of the region. The IT InnovationLab offers room for experimentation and for exploring all possible ideas for practice-oriented research questions within the IT domain. The InnovationLab is designed to stimulate chance meetings between people with specific know-ledge. That is because many surprising new insights, products and business models arise from accidental encounters.

  Source: Fontys ICT InnovationLab | Innovation District Strijp T (idstrijp.nl)

- **Fontys Centre of Expertise HTSM**
  The Fontys Centre of Expertise High-tech Systems and Materials (HTSM) connects higher education to the business community. Together, they carry out research and develop innovative technologies that improve both the world of education and of business. In addition, the center provides learning solutions to promote the mobility and flexibility of technical professionals.

  The center is home to several departments and research groups.
  The following are relevant to the IT & Data sector:
  - AI and Big Data
  - Health, Innovation, and Technology
  - High-tech Embedded Software
  - Smart Manufacturing

FONTYS IT & DATA SCIENCE RESEARCH GROUPS

Research Group	Research topics
AI and Big Data	Big data science aims to provide insight into and create value from large, complex, and dynamic data collections. This includes a large amount of unstructured data that current databases cannot handle.
High-tech Embedded Software	The department focuses on two areas of application – mobile robots and sensor networks. These systems are examined from a systems perspective, with four system aspects identified, being architecture, integration and testing, modeling and learning, and software quality.
Humanities and Technology	The Humanities and Technology research group studies the influence of people and technology upon each other and conducts hands-on research at the interface of technology and psychology
Smart Manufacturing	This group devotes itself to disruptive technologies and their application in the manufacturing industry. Examples include the Internet of Things, artificial intelligence, connectivity, robotics, 5G, 3D printing, and autonomous mobility.
Serious Game Design and Technology	The Serious Game Design research group is engaged in research into various aspects of gaming. The group researches and comes up with new opportunities for the use of games in healthcare, culture, entertainment, and education.
Virtual Reality	The Fontys Virtual Reality Lab has state-of-the-art techniques in computer graphics, visualization, and virtual reality. New products or processes can be visualized in the lab on behalf of companies.
Distributed Sensor Systems	The major research objectives are: Sensing: signal conditioning, data fusion Processing: signal processing – audio, video, Computing architectures: FPGA, SoC, embedded systems, real-time Actuating: human machine interfaces, cyber-physical systems, Interconnectivity: WIRED and wireless: IoT/IIoT, communication protocols
Health Innovations & Technology	Through a focus on three current themes, Fontys actively contributes to healthcare advances in general and the paramedical professions in particular. The three themes are: • Technology in healthcare • Interprofessional collaboration • Empowering healthy behavior

FONTYS RESEARCH PROJECTS

The research conducted at Fontys is practice-based and innovative. Examples of applied innovative and practical IT and Data Science research projects that Fontys carries out in close cooperation with and for the professional field include:

- **AI & Big Data for Biodiversity:** The goal of the project is to create and standardize affordable large-scale AI biodiversity monitoring.
- **VETIS:** The results of the study will be used to investigate how the range and energy consumption of buses and trucks can be improved.

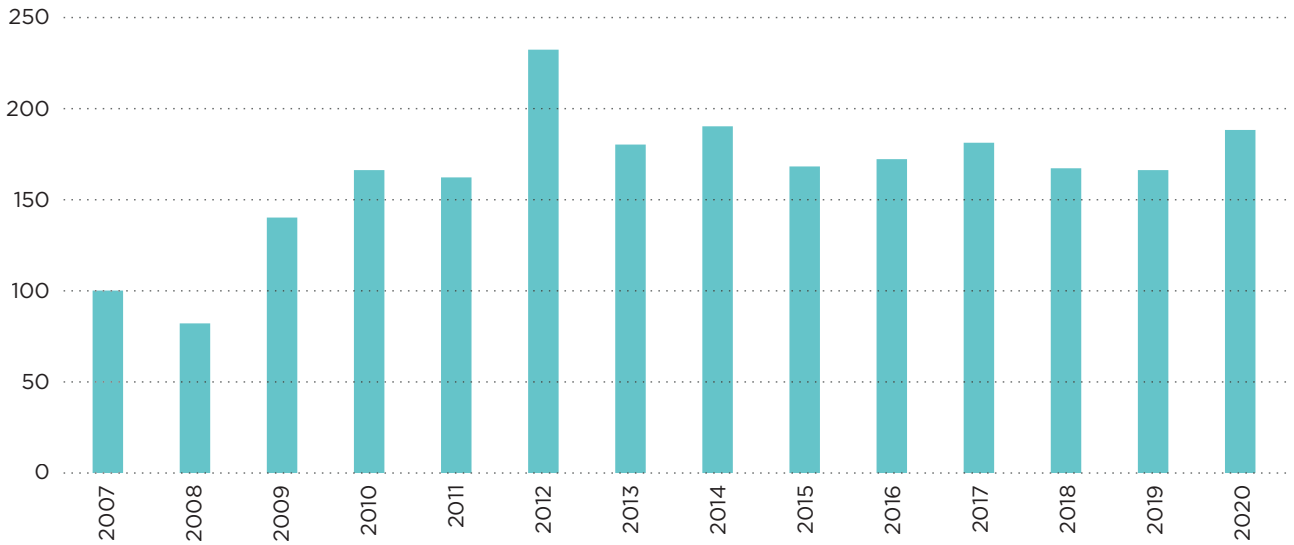
5. Breda University of Applied Sciences (BUAS)

The Breda University of Applied Sciences is a medium-sized, government-funded higher education institution, with over 7,000 Dutch and international students from around a hundred countries. The BUAS offers bachelor's and master's degree courses at a professional and academic level.

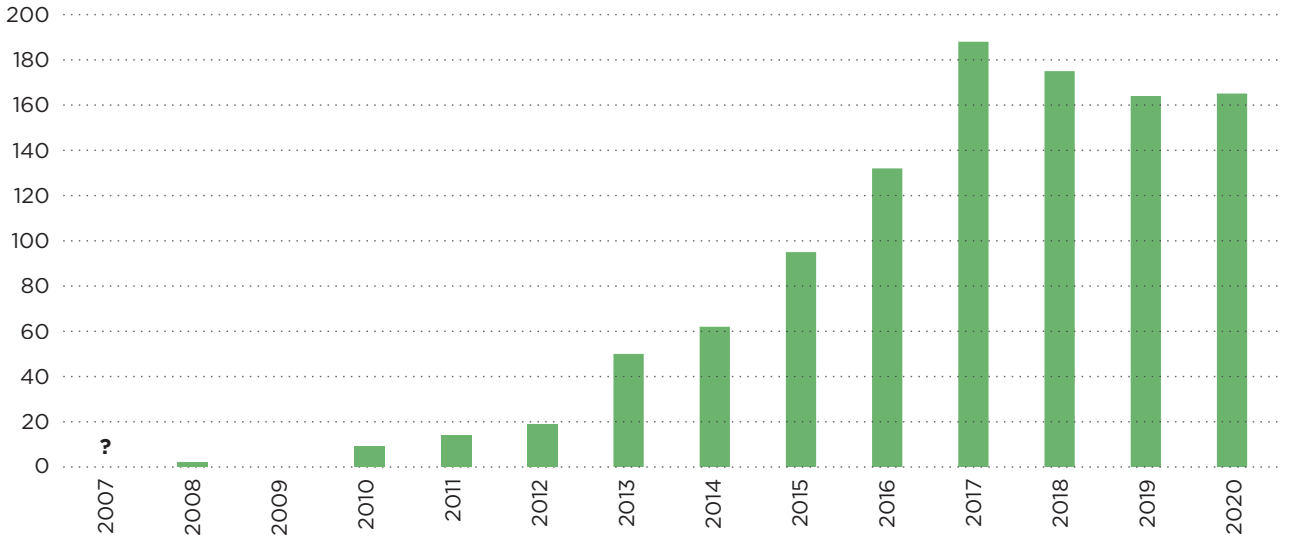
The BUAS specializes in:	
Games	**Logistics**
Media	**Built Environment**
Hotel	**Tourism**
Facility	**Leisure & Events**

IT STUDENTS AT THE BREDA UNIVERSITY OF APPLIED SCIENCES:

New IT Students



Graduates



Source: CA-IT (2021) Expertise Center Digitization IT

IT-RELATED COURSES AT THE BREDA UNIVERSITY OF APPLIED SCIENCES:

Breda University of Applied Sciences
Bachelor of Creative Media and Game Technology
Bachelor of Data Science & Artificial Intelligence
Master of Media Innovation
Master of Game Technology
Master of Creative Business

IT and data play an important role in all of the eight fields that the BUAS focuses on. The two main areas for IT & Data Science are:

A. Games research program

Games are part and parcel of our lives. They shape interesting new gaming cultures, such as in e-sports. The gaming industries are responsible for many innovations, while game technology can also be used for non-entertainment purposes, such as game-based learning, urban planning, or medical systems. The Games research program at the BUAS focuses on digitally enhanced realities (DER), new forms of human interaction in environments designed with games blended with Big Data, geo-data, simulations, robotics, and AI. The BUAS is home to its own research lab: The CRADLE lab, where the next generation of games and digital media products and services are designed and created.

The program consists of two types of games:

1. Entertainment games, focusing on gaming cultures and the design and creation of video games. Students study the content of video games, the processes and tools for creating them, and the surrounding culture. Within this broad field there is a focus on issues relating to diversity, storytelling, interface design/feedback, and puzzle design (using "escape rooms" as a thematic entry point). The research team works closely with the international AAA video game industry.

2. Serious games, focusing on how games can be used to improve the performance of organizations and systems. Many industries and societal sectors are interested in harvesting the potential benefits of gaming technologies and game concepts. In this lab, gaming technology (including VR and AR) and game concepts are designed, developed, and used to profit from the deep impact that they can have on professionals, teams, organizations, or complex systems. Areas of application for serious games are spatial planning, logistics, sustainability and ecological systems, tourism, entrepreneurship, management, leadership, and change.

Relevant games research projects are:

- **MSP Challenge Simulation Platform:** uses game technology and roleplaying to support communication and learning for marine and maritime spatial planning.
- **Gaming Horizons:** the Gaming Horizons project seeks to open up new areas of public value for the games industry as a whole, beyond the industrial distinction between "leisure" and "serious" games. The following technologies play an important role in the project: virtual reality, augmented reality, and artificial intelligence.

Source: Games Research | Breda University of Applied Sciences (buas.nl)

B. Media

The program focuses on the added value and experience of new digital media compared to traditional media. Just like the gaming industry, digitally enhanced realities (DER) play an important role in this program. DER are new forms of human interaction in media environments designed using games, big data, simulations, robotics, and AI.

Relevant research projects are:

- **VIBE:** Project Virtual Humans in the Brabant Economy (VIBE) focuses on developing and testing virtual humans. The virtual humans developed by VIBE will be able to communicate with normal people in a natural way, both verbally and non-verbally, and make a valuable contribution to the training of healthcare professionals. The tools developed by VIBE can be used in any training simulation in various instances, including virtual, mixed, and augmented reality.
- **The Thermo Fisher Scientific project:** Thermo Fisher Scientific is exploring augmented and virtual reality (AR and VR) applications for electron microscopy and corresponding business cases for future projects. The Central Services Department is driving research related to training and service solutions using AR and VR, as it recognizes the vast benefits these technologies can offer its customers around the globe.
- **Recovry:** creating and testing a virtual reality therapy application for reducing alcohol addiction.
- **VIRGiN:** VIRGiN uncovers types of local and regional storytelling techniques that fit virtual reality, based on research among journalists as well as professional and user-generated VR concepts.

THE OTHER RESEARCH FIELDS, AND EXAMPLES OF THE WORK THEY DO, INCLUDE:

#	Field	Examples of IT research projects
C	**Tourism**	**Digitourism:** intends to improve the policies of the eight partner regions in order to foster tourist-channeled digital innovations (such as VR and AR)
D	**Logistics**	**Data Science for Logistical Innovation (DALI):** the DALI project falls under the Logistics Community Brabant. DALI is a testing ground aimed at raising datafication in the logistics industry in the southern Netherlands to a higher level, future-proofing the industry.
E	**Leisure and event**	**Experiencing a VR rollercoaster:** a study of how virtual reality headsets can improve the experience of existing rollercoasters by boosting sensations.
F	**Built environment**	**Urban Intelligence:** this project is developing new policy concepts by encouraging the use of smart data. It focuses on linking expertise in transport engineering, urban planning, and urban design to big data technologies.
G	**Facility**	**Brightful:** improving facility-experience and performance by creating smart solutions.
H	**Hotel**	**Smart City Hospitality (SCITHOS):** this project seeks to support cities in creating policies and solutions for dealing with issues such as overtourism. The SCITHOS program combines hospitality principles, simulation tools, apps, and serious gaming techniques to support policymakers and other stakeholders in generating collaborative deep reflections on barriers to sustainable urban tourism and the need for transition or adaptation strategies.

6. Avans University of Applied sciences

The Avans University of Applied Sciences provides education and hosts research in ten different fields and across 13 locations in Breda, Den Bosch, Tilburg, and Roosendaal. Avans has six centers of expertise and more than 25 research groups. These groups of researchers conduct practical research.

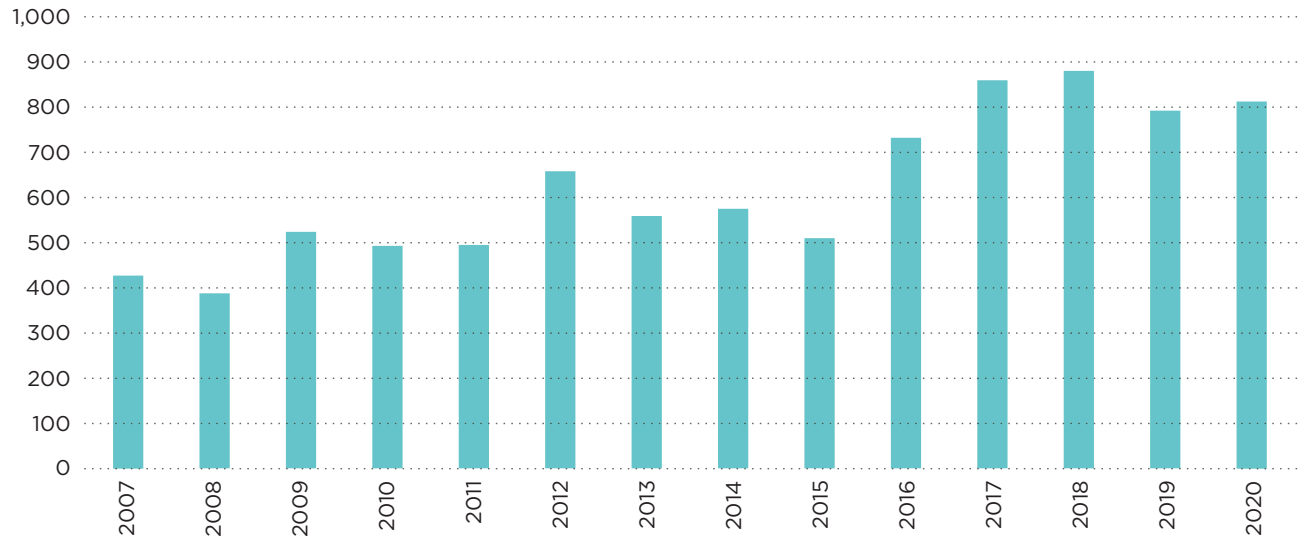
In December 2020 there were **35,083 students** registered with Avans, with a **professional staff** contingent of **3,300**.

Avans conducts research through a number of research groups, the majority of which are part of one of the centers of the following applied research:

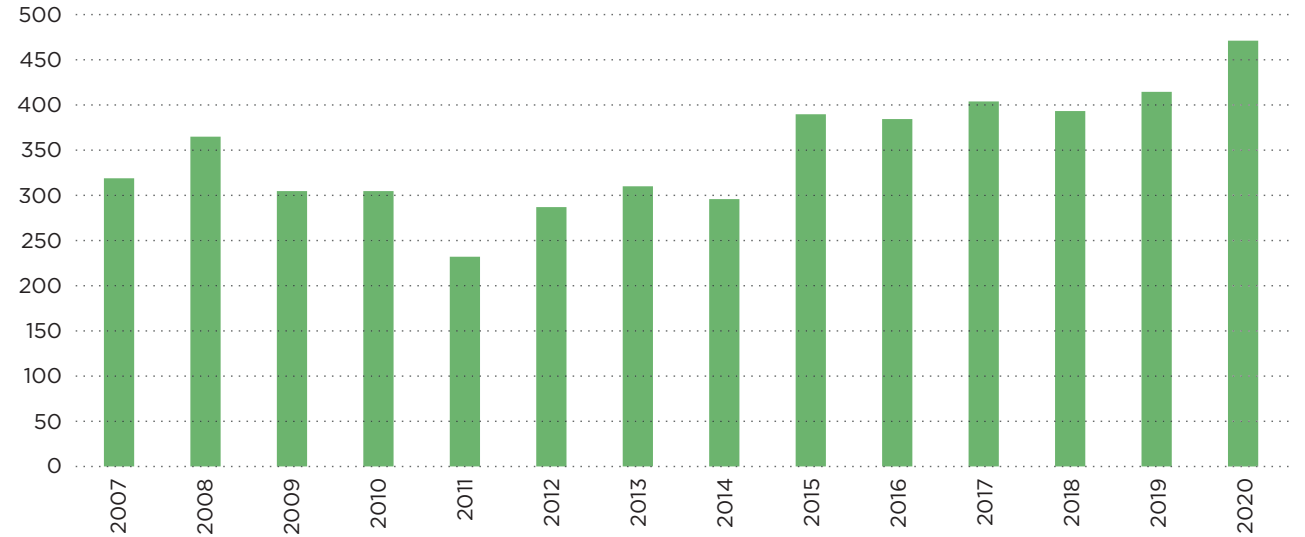
- Art, Design and Technology
- Caring Society 3.0
- Center of Expertise Biobased Economy
- Public Safety and Criminal Justice
- Sustainable Business
- Technical Innovation

IT STUDENTS AT AVANS UNIVERSITY OF APPLIED SCIENCES:

New IT Students



Graduates



Source: CA-IT (2021) Expertise Center Digitization IT

IT-RELATED COURSES AT THE AVANS UNIVERSITY OF APPLIED SCIENCES:

UAS Avans
Associate Degree in Informatics
Business IT & Management
Communication and Multimedia Design
Informatics
Technical Informatics
Master Animation

THE FOLLOWING RESEARCH CENTER IS RELEVANT TO THE IT AND DATA SCIENCE SECTOR:

- **Center of Applied Research for Technical Innovation (CARTI)**
  The Center of Applied Research for Technical Innovation (CARTI) focuses on creating technical innovations for a sustainable world. The overarching theme is the Resilient City: a livable, resilient, and sustainable urban environment. CARTI is a joint initiative involving all the engineering study programs at the AVANS University of Applied Sciences. Professors, researchers, lecturers, and students have organized themselves into research groups to conduct practice-based research into the development of the resilient city. The research is carried out at the request of businesses and organizations.

  The Resilient City
  The fields of activity of the departments cover various aspects of the Resilient City. It is of great importance that cities be prepared for a sustainable future, in view of increasing urbanization, the energy transition, and material scarcity and waste. An integrated approach is required for this transition. Accessibility, livability, sustainability, air quality, sound health, and economic vitality are all inextricably linked to that transition. Moreover, increasing urbanization and the changing composition of households pose environmental, infrastructural, and security challenges. CARTI seeks solutions to this in a circular economy, robotization, and the creation of smart cities – cities with, for example, highly developed public transport systems and online platforms that make organizing the city a more efficient process.

THE EXAMPLE OF A DATA SCIENCE & IT PROJCT PERFORMED BY CARTI:

"Data-Wasmachine" (Data Washing Machine)
The project charts how "clean" data is, and to what extent it can be shared with others. When processing data, one can determine which data aspects are sensitive and should therefore be anonymized. In addition, it must also be possible to set the degree of anonymization.
And so, for each data question one must be able to consider to what degree the data has been "cleaned" of sensitive information, and must be compared to the degree of similarity between the anonymized dataset and the original dataset.

B. Knowledge institutes in IT & Data Science in Brabant (a selection)

1. Eindhoven Artificial Intelligence Systems Institute (EAISI)

The Eindhoven AI Systems Institute brings together all TU/e artificial intelligence activities. Top researchers from the various research groups work together to create new and exciting AI methodologies and applications with a direct impact on the real world. Through the establishment of EAISI (pronounced "Easy'), the Eindhoven University of Technology aims to contribute to the growing importance of AI in society, business, and science, and to meet the rapidly increasing demand for education, engineers, and expertise in the field of AI.

EAISI calls this: "AI for the real world".

The TU/e has been active in the field of artificial intelligence for decades, which gives the new institute an excellent starting position to build on. Using its traditional strengths in systems engineering and close ties with industry, the TU/e aims to leverage the huge potential of AI to real-world applications in industrial engineering systems. The institute embodies the ambition of the TU/e to play a leading role in the further development of this groundbreaking technology.

EAISI will include the existing activities of the following TU/e organizations: the Data Science Center Eindhoven, High Tech Systems Center, and the Smart Mobility strategic area of focus. The combination of these activities in a single institute offers advantages in terms of synergy between researchers, fundraising and talent recruitment, cooperation with the business community, and profiling the TU/e as a leading body in the field of AI.

EAISI focuses on the use of data and algorithms in machines, such as robots, autonomous cars, and medical equipment, which has always been a strong aspect of both the TU/e and the Eindhoven Brainport region. In addition, the institute focuses on the interaction between humans and systems, including trustworthy and transparent methods resulting in moral and ethical AI. Specifically, the research focuses on the following topics:

High-tech systems and robotics:
Guaranteed machine performance
Autonomous machine operation and smart human-operator support
Multi-agent robotics
Predictive maintenance

Health applications:
Improved diagnostics
Personalized and wearable health
Better understanding of personal health
Preventive health management

Smart mobility:
Vision and sensor capabilities for autonomous driving
Data analytics for effective transportation systems and distributed traffic management
Advanced driver assistance systems

Building on the traditionally close ties of the TU/e with industry, EAISI is partnering with a number of leading companies and organizations at a regional, national, and European level, including:

- ASML
- NXP
- AI NL Coalition
- EuroTech
- Philips
- Brainport Eindhoven
- 4TU.Federation

Source and more info: https://www.tue.nl/en/research/institutes/eindhoven-artificial-intelligence-systems-institute/

2. EMBEDDED SYSTEMS INNOVATION BY TNO

Originally founded in 2002 by the industry-leading companies ASML, Océ, Philips, and TNO, together with the Delft University of Technology, Eindhoven University of Technology, and the University of Twente, the former Embedded Systems Institute (ESI) was integrated into TNO as Embedded Systems, Innovation by TNO (TNO-ESI), in January 2013. The TNO-ESI program represents the special interests of the national high-tech OEM and SME industries, and addresses current and future needs in fields such as mobility, health, and safety and security. Through an open innovation structure, the TNO-ESI collaborates with a wide range of industrial and academic partners, helping them stay ahead of the innovation curve and lead innovations in embedded systems technology.

The ESI is a leading applied research center for systems design and engineering in the high-tech equipment industry. It works closely with Dutch industry and utilizes the fundamental research conducted in the academic realm, both nationally and internationally. The ESI contributes to society and the economy by driving advances in high-tech systems technology through a strong shared research program, dedicated innovation support, a focused competence development program, and various knowledge and experience-sharing activities. Through its strategic research projects, it demonstrates how to put fundamental knowledge - including the latest insights into model-driven engineering - into practice in the harsh reality of industry.

Source: www.esi.nl

ESI
An initiative of industry, academia and TNO

3. Eindhoven Institute for the Protection of Systems and Information

Eindhoven Institute for the Protection of Systems and Information is a TU/e research institute that covers the entire technical spectrum of information security, with a special focus on:

- methods and techniques to protect digital information against unintended effects and interference
- the study and design of more complex applications in which security goals like confidentiality, integrity, authenticity, reliability, and availability of data play a crucial role

Eindhoven Institute for the Protection of Systems and Information was launched on October 1, 2007, continuing the work of the Coding and Cryptology group in mathematics and combining it with the then-new Security group in computer science. This Security Group is financed by CeDICT, the Center for Dependable IT Systems, one of the centers of excellence of the 3TU federation of technical universities in The Netherlands. In 2012 the Cryptographic Implementations group joined Ei/. Ei/ participates in the security activity of NIRICT, the Netherlands Institute for Research on IT.

Source: EiPSI General information (tue.nl)

Eindhoven Institute for the Protection of Systems and Information

4. Holst Centre

The Holst Centre was launched in 2005 by imec (Flanders, Belgium) and the TNO (the Netherlands) and is supported by local, regional, and national governments. It is named after Gilles Holst, a Dutch pioneer in research and development and the first head of Philips Research. Located on the High Tech Campus Eindhoven, the Holst Centre benefits from, and contributes to, the state-of-the-art on-site facilities. The Holst Centre has over 200 employees from 28 nations, has 56 industrial partners, and has funding for 45 ongoing projects. The Holst Centre is an independent research and innovation center that focuses on innovations for improving health and wellbeing and on guaranteeing sustainable environments. The institute bolsters its industry partners by developing world-class breakthrough technology solutions that can be marketed. To help solve global challenges, the Holst Centre links the Dutch Brainport region with a global ecosystem of industry partners and academia, allowing each sector to benefit from the other's expertise.

WIRELESS SENSOR TECHNOLOGIES AND FLEXIBLE ELECTRONICS

Combining expertise in wireless sensor technologies and flexible electronics means that the Holst Centre is in a unique position. The institution's partner companies value its ability to create demonstration models and prototypes and, using such a proof-of-concept, industrial partners transform these innovative technologies into new products and new manufacturing processes. The Holst Centre frequently takes technologies to a point where they are almost ready for market. Thanks to knowledge transfer, the Holst Centre contributes to the expertise and market position of its partners.

OPEN INNOVATION MODELS

The goal of open innovation is faster, cheaper, and more effective innovation, reducing risks and creating a rapid time-to-market for new products. At the Holst Centre, partners complement their in-house R&D with shared R&D, leveraging each other's talents and knowhow in a well-structured and professional environment. Outcomes generated at the Holst Centre tend to be shared on a non-exclusive basis between program partners, under agreements that are tailored to the needs and scenarios of each partner. Where necessary, the Holst Centre also performs dedicated research in the form of a one-on-one agreement with a single partner. This is often done to speed up technology transfer and the industrial uptake of results garnered through such shared research, and which have reached a higher level of technological readiness. This working model also plays a role in partnerships with SMEs, which typically have more immediate R&D needs. Dedicated partnership and IP agreements are negotiated with these companies.

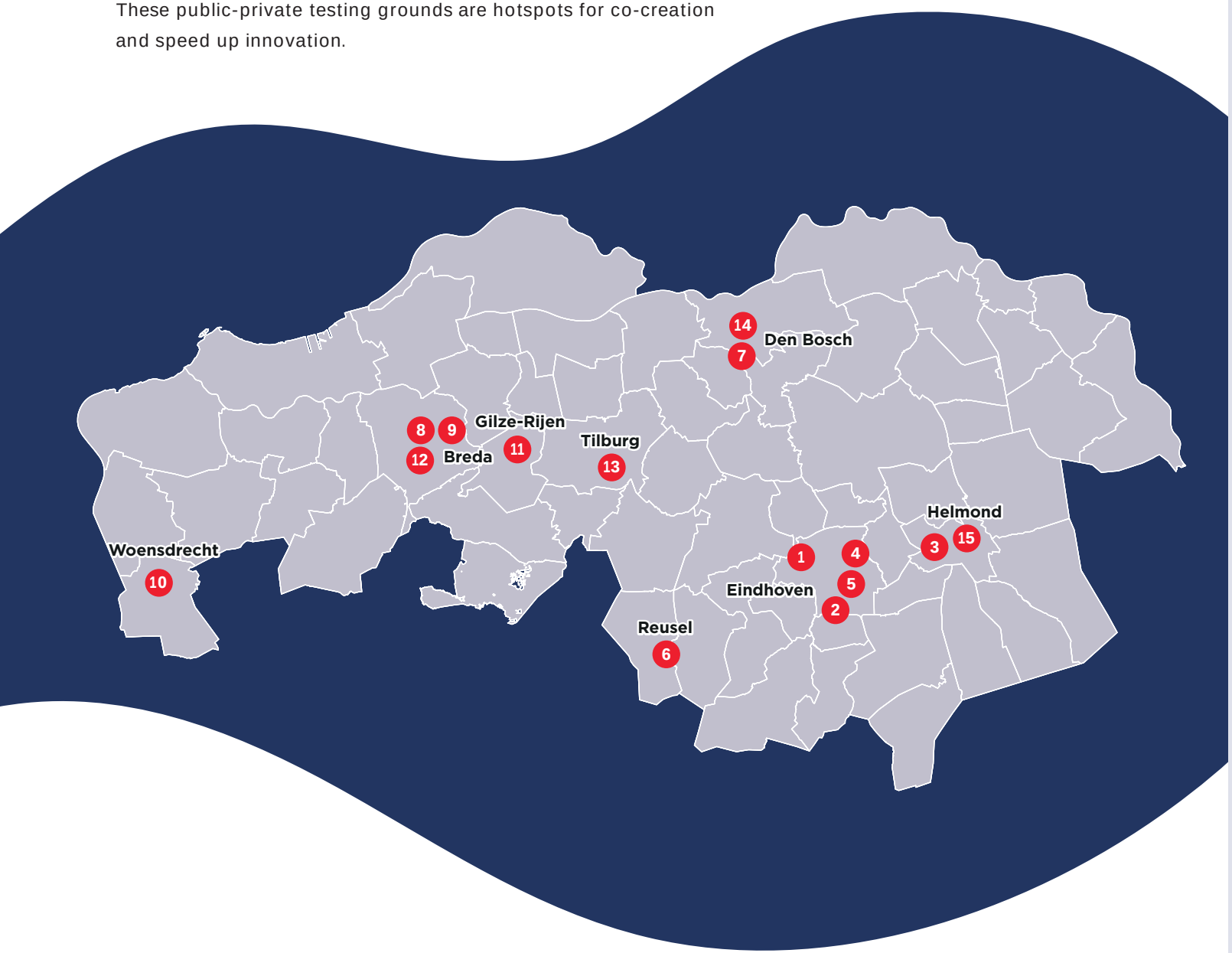
C. Field labs and innovation hubs for IT & Data Science: digital experimental gardens, Brabant 2020

Through field labs and hubs, the Brabant region aims to encourage the creation and use of new technologies. In a field lab, entrepreneurs, together with knowledge institutes and public bodies, are given the space to experiment with new technologies. A field lab is an excellent catalyst for promoting IT developments and sharing knowledge and risks.

Field labs are real-life testing sites where a range of parties join forces to develop, test, learn to implement, and scale up new technologies for commercial applications. These field labs bring together researchers, students, entrepreneurs, and companies and enable them to accelerate IT & Data Science innovations for a specific industry or application. Thanks to the close involvement of researchers, the industry, government agencies, and end-users, these innovations can be brought to society at an accelerated pace.

Brabant is home to most of the IT & Data Science field labs in the Netherlands.

What sets Brabant apart from the rest of Netherlands, are the various innovation clusters and field labs around specific themes. These public-private testing grounds are hotspots for co-creation and speed up innovation.



1 **Brainport Industries Campus, Eindhoven**
- Advanced Manufacturing Logistics
- Flexible Manufacturing
- Multi- M3D Field Lab
- High Tech Software Cluster
- Smart connected supplier network
- 5G Manufacturing Industry field lab
- Data Value Center Smart Industry

2 **High Tech Campus, Eindhoven**
- 5G Hub HTC
- Cyber Resilience Center
- Autonomous Drones - Flying Forward
- AI Innovation Center

3 **Automotive Campus, Eindhoven**
- 5G Automotive field lab

4 **TU/e Campus, Eindhoven**
- BrainBloc
- ICAI: e/MTIC AI-Lab
- ICAI: Mobility Lab
- ICAI: AIMM Lab
- ICAI: FAST Lab

5 **De Effenaar, Eindhoven**
- Social Cohesion field lab

6 **Reusel**
- National Experimental Garden Precision Agriculture

7 **JADS, Den Bosch**
- Data Value Center Smart Industry
- ICAI: KPN Responsible AI Lab

8 **World Class Maintenance, Breda**
- VIA APPIA
- “Samen” - Together
- Capella field lab

9 **BUAS, Breda**
- Data science for logistics innovation (DALI)

10 **Aviolanda, Woensdrecht**
- Composite Maintenance and Repair field lab

11 **Gate 2, Gilze-Rijen**
- CAMPIONE 2 field lab

12 **Breda**
- Smart Living City Lab
- Breda Robotics

13 **Tilburg**
- ICAI: Masterminds Lab

14 **Den Bosch**
- SPARK Industry Field LAB
- Agro-proeftuin De Peel’

15 **Helmond**
- Smart District
- Industrie 4.0 De Peel

1. Eindhoven/Helmond region (southeast Brabant)

Logo	Name	City	Description
	Advanced Manufacturing Logistics	Eindhoven	Smart Industry field lab - A state of the art logistics system – that is the goal of the Advanced Manufacturing Logistics (AML) field lab. Further development and knowledge on storage and movement, smart automation, and smart robotics in a collaborative supply chain are essential in this respect. This approach will result in faster delivery times and higher productivity with fewer logistics resources and investments.
	Flexible Manufacturing	Eindhoven	Smart Industry field lab - In the Flexible Manufacturing field lab, more than 20 companies and knowledge institutes work together to demonstrate the opportunities that automation and robotization offer for the flexible and high-quality execution of small series production at mass-production costs.
	Multi- M3D field lab	Eindhoven	Smart Industry field lab - The ultimate potential of additive manufacturing is freedom in product design and manufacturability. This makes it possible to produce functional products at a low cost in a flexible and small-scale manner. For many applications, multi-material 3D printing will play an important role, and this is what Multi-M3D focuses on.
	High Tech Software Cluster	Eindhoven	The High Tech Software Cluster is a partnership of over 30 innovative software companies, research organizations, and educational institutions that support companies in making digitization affordable and practical. For many entrepreneurs, digitization – a.k.a. Industry 4.0 – is a vague term that refers to very interesting concepts but is not clearly related to the immediate needs of their business.
	Smart connected supplier network	Eindhoven	Smart Industry field lab - It is not yet easy to link IT systems between companies. Current practice shows that many companies do so manually: employees manually transfer information from an incoming order into their own system. The partners of the Smart Connected Supplier Network field lab are looking for solutions to this issue.
	5G Hub HTC	Eindhoven	5G field lab - In Eindhoven, residents, students, startups, and companies can start using "real 5G" as of the second half of 2019 at a number of test locations, with the aim of improving the city. The focus will be on new applications that 5G makes possible. The latest 3.5 GHz devices can also be tested here.

Logo	Name	City	Description
	5G Manufacturing Industry field lab at the Brainport Industries Campus (BIC)	Eindhoven	In this 5G field lab for the manufacturing industry, the focus is on the indoor use of 5G in a factory environment. This includes virtual and augmented reality for production control, autonomous AGVs (automated guided vehicles), and 4K cameras for quality and safety, to name just a few. This is not only about speed but also about reliability and minimal network delays. Unlocking large numbers of wireless sensors will also play an important role in the further rollout of the Internet of Things (IoT). The goal is to get the most out of the added value of a "wireless factory', together with the partners and customers at the BIC.
	5G Automotive field lab	Helmond	KPN is conducting tests at the Automotive Campus to increase road safety and reduce fuel consumption using 5G technology. If the tests are successful and the experiments are put into practice, the social benefits will be extensive. Improved usage can be made of the road network, traffic flow will improve, and congestion decrease.
	Data Value Center Smart Industry Eindhoven	Eindhoven	SBig Data Hub - the Data Value Center - Smart Industry helps companies create added value and become more competitive through the use of data. The center supports entrepreneurs, decision-makers, and professionals in using data optimally: the optimization of processes, the development of new services and revenue models, and the strengthening of the required knowledge and competences.
	Smart Districs	Helmond	The smart city district in the city of Helmond, the Netherlands. It's located in the high-tech innovative region 'Brainport'. The latest insights and techniques about participation, health, data, mobility, energy and circularity are used here to create a sustainable and beautiful environment. BSD will be a smart living and working area in which residents play a central role in the development of their own living environment.
	Cyber Resilience Center	Eindhoven	Cyber resilience network - Whether they have outsourced the entire IT department, it is in-house, and whether they have set up their own professionalized SOC or do not (yet) have expertise in cybersecurity, the CWB can be of service to almost any company involved in the high-tech industry in the Netherlands. SMEs in the high-tech supply chain are a special area of focus.
	National Experimental Garden Precision Agriculture	Reusel	Smart Industry field lab - The National Experimental Precision Agriculture project assists farmers and horticulturists in the world of precision agriculture. Agricultural companies receive assistance from Wageningen-based experts to get started using precision agriculture on their farms. Through the participating companies, the Ministry of Agriculture, Nature and Food Quality (LNV) wants to help all farmers to take this step forward.

Logo	Name	City	Description
	Social Cohesion field lab	Eindhoven	The Social Cohesion field lab, which is located in the Effenaar music venue in Eindhoven, is working on the functioning and use of social cohesion in transitions and bringing about change with the help of new technology, such as virtual reality (VR) and augmented reality (AR). Over a period of two years the field lab will use ten short-term, small-scale experiments to discover how new technologies can play a role in promoting social cohesion and the realization of more complex transitions, as well as what the effect of that will be. Designers, high-tech companies, and research and training institutes work closely together on solutions that are directly tested in the real world.
	Autonomous drones Flying Forward	Eindhoven	The focus of this fieldlab is on the testing of autonomous flying drones. This to further appropriate legislation for urban air mobility. The main goal of this fieldlab is to use UAS to take measurements. Autonomous drones that measure the high tech campus area continously and in real-time through sensors, monitoring the quality of life (of people, security and sustainability). The operating system will use these measurements (through a digital twin) which enables the possibilities to proactively manage the operation of the campus, scenario planning and predictive maintenance in a virtual boardroom (in VR/AR).
	BrainBloc	Eindhoven	BrainBloC provides access to an accessible environment in which people can become acquainted with new (general-purpose) data technologies (sensors, blockchain, AI) and discover what you want to use and how you could use it. The first step involves creating a solid basis ("data organization" and what "rich data" means), then focusing on proper implementation. BrainBloC focuses on "thinking and acting differently', where data (tech-nology) forms the starting point for new business processes and organizational models.
	ICAI Labs	Eindhoven, Den Bosch & Tilburg	More information in chapter 7. B. Successful public-private partnerships (ppps) and networks in Brabant.
	Industry 4.0 de peel	Helmond	A large group of companies work together in this test environment on high-tech innova-tions to take their company to the next level. In the lab it's all about data and how to use data to make predictions for the future. The main focus of the fieldlab is on industry 4.0
	AI Innovation center	Eindhoven	The AI Innovation Center is an open innovation facility founded by High Tech Campus Eindhoven, Philips, Signify, ASML and NXP. The centers goal is to industrialize Artificial In-telligence technologies in the Brainport Eindhoven region. The AI Innovation Center brings together technology companies, platform & service providers, research & educational institutes and other relevant ecosystem partners in a shared facility. In this hub, located in the heart of Europe's smartest square kilometer, partners work together on challenges, share knowledge and accelerate AI applications in an open innovation environment.

2. Breda region (western Brabant)

Logo	Name	City	Description
	Composites Maintenance and Repair field lab	Aviolanda, Hoogerheide	Smart Industry field lab – The Composites Maintenance and Repair field lab focuses on the complete automation of maintenance and repair of composites. Composites have been widely used in the construction of new aircraft (including the Boeing 78, Airbus 350, and F-35) since 2010. The field lab develops smart industry technologies for the maintenance of these aircraft.
	Smart Living City Lab	Breda	Supporting municipalities in the digital transformation in public spaces, by setting up living labs to gain experience and to safeguard them organizationally. The program consists of a measuring network for air quality and project management. Every municipality can participate with respect to the Environment Act, the Clean Air Agreement, environmental measures, traffic, participation, and quality of life.
	Data Science for Logistics Innovation (DALI)	Breda	Under the name DALI (Data Science for Logistics Innovation), concrete applications of data science in the supply chain are created on the basis of business cases. DALI is a testing ground for raising data certification in the logistics industry in the southern Netherlands to a higher level and thus making the industry future-proof.
	Breda Robotics	Breda	Smart Industry field lab - Breda Robotics was created to encourage robotization in the region by facilitating and developing robotics and other Industry 4.0. technology. Focusing on the manufacturing and maintenance industry and vocational education, Breda Robotics provides an inspiring work and training place. Breda Robotics connects, inspires, and answers questions related to robotization and automation.
	Field lab VIA APPIA World Class Maintenance	Breda	The objective of the VIA APPIA field lab is to use AI and VR/AR within a maintenance and service context by combining the strengths, knowledge, and experiences of project participants. Jointly analyzing where the best opportunities lie and determining the implementation of AI and VR/AR can lead to valuable industrial applications.
	Field lab "Samen"-Together by World Class Maintenance	Breda	The aim of the SAMEN field lab is to strengthen the Smart Maintenance innovation system, based on the philosophy that 100% predictable maintenance in the manufacturing and processing industry will only be achieved through new revenue and organizational models. The participating companies work in different groups on sub-projects to develop knowledge products through practical cases, validate these knowledge products, and ensure that the knowledge is safeguarded and becomes available to other SMEs in the future.

Logo	Name	City	Description
	Capella field lab	Breda	The CAPELLA field lab has a radical goal: to render the performance of machines in the manufacturing industry 100% predictable. This is only possible if maintenance is 100% predictable. The goal will also significantly reduce maintenance costs and increase the availability and reliability of machinery.

3. Tilburg region (central Brabant)

Logo	Name	City	Description
	Field lab CAMPIONE 2	Gilze-Rijen	Smart Industry field lab – The CAMPIONE 2 field lab, created by World Class Maintenance, focuses on 100% predictable maintenance in the processing industry. The field lab has a test installation available to all CAMPIONE partners in Gilze-Rijen. In addition, a number of Living Labs are operational at the companies themselves. The tests mainly concern the use of sensors for measuring the load on installations. Examples of technologies include data science, IoT, and VR/AR.

4. Den Bosch region (northeastern Brabant)

Logo	Name	City	Description
	Data Value Center Smart Industry	Den Bosch	Big Data Hub - the Data Value Center - Smart Industry helps companies create added value and become more competitive through the use of data. The center supports entrepreneurs, decision-makers, and professionals in using data optimally: the optimization of processes, the development of new services and revenue models, and the strengthening of the required knowledge and competences.
	SPARK Industry Field LAB	Den Bosch	Smart Industry field lab - SPARK Makers Zone is a creative workplace where expertise in the field of 3D printing (xs-XL, including metal printing), milling (xs-XL), robotics, the Internet of Things and biobased materials development all feature. The workshop is open to individuals, students, companies, artists, and other interested parties. The mutual expertise and the mix of manufacturers stimulates knowledge development and reduces the distance between education and practice, or between idea and realization.
	Agro Proeftuin De Peel	Den Bosch	In AgroProeftuin de Peel, pioneers are working on sustainable, future-oriented agricultural production. The focus is on agriculture with as little waste and emissions of harmful substances as possible and where raw materials and end products are used and re-used as fully as possible.

ARTICLE: FIVE TEST CENTERS IN THE NETHERLANDS FOR AI APPLICATIONS FOR SMES

Good news for Dutch SMEs: there are five field labs where they can turn to for the application of AI in their production process. This became clear during the EAISI Summit in Eindhoven.

Since last year, the Netherlands has five centers where small and medium-sized companies (SMEs) can test the integration of applications that use artificial intelligence or AI in their manufacturing processes. Namely, RoboHouse in Delft, Fieldlab Flexible Manufacturing on the Brainport Industries Campus in Eindhoven, Region of Smart Factories in Groningen, Campione 2 from the World Class Maintenance organization in Gilze-Rije, and lastly, TValley in Enschede. Jelmer Alberts, the AI specialist representing the FME advocacy organization for technology companies in the Netherlands, made this announcement during the EAISI Summit in Eindhoven at the end of November last year. EAISI stands for the Eindhoven AI Systems Institute and is a leading research organization of the Eindhoven University of Technology (TU/e). It focuses on the development and application of AI in industries, among other things.

The arrival of the five field labs for AI applications is very good news for the Dutch business community. The European Commission has already been busy for several years with linking SMEs to networks that help entrepreneurs make use of AI. This is a problem throughout Europe, given that small and medium-sized entrepreneurs often do not have enough time and money to adapt their manufacturing processes. This requires a thorough analysis of the manufacturing process, specific knowledge to assess which type of AI can best be introduced, and, of course, money to purchase new equipment and systems as well as further training.

Even a butchery can test out a robot

The five AI hubs, as the field labs are called, are spread all over the Netherlands. But that does not mean that there is always a suitable hub for every company just around the corner. As the Netherlands is just a small country, that should not be such an insurmountable problem.

Each field lab has its own specialty. As the name suggests, RoboHouse is specialized in the use of robots in manufacturing processes. Consider a robot that performs tasks on an assembly line. Or one in a butchery or bakery that carries out packing chores in ice-cold storerooms. Very handy, because who enjoys spending hours in these areas? Nobody of course, and a robot does not feel a thing.

There is the Smart Factories field lab in Groningen that specializes in sensor technology. This is where you can imagine the application of sensors to keep track of all kinds of data, such as temperature, humidity, how many people walk past a certain point, how hot a particular machine gets when it is running, and so on.

Sensors and starfish

TValley in Twente combines AI with robotics and sensors in machines. Then you have Fieldlab Flexibel Manufacturing in Eindhoven for AI in combination with AR (augmented reality) applications, vision systems (such as automated visual inspection) and robotics. For instance, consider a camera on a fishing boat that can recognize whether a fish is plaice or sole etc by the shape of the fish they catch. And this fish has already been selected and digitally registered on the fishing boat's conveyor belt. Or if it is a starfish that has to be thrown back. Or imagine that the AI analyzes that in a certain area, plaice are often caught that are far too small and cannot be sold (because they do not have enough flesh on them. Then this can help fishermen decide to sail to an area where mostly larger plaice swim. This increases their yield and reduces the risk of having to throw back immature fish.

Preferably no double costs

Campione 2 of World Class Maintenance in Brabant is the place to be for using AI to optimally utilize and maintain industrial machinery. According to the director of Campione 2, Paul van Kempen, the use of AI for maintaining machinery is crucial for making a profit. “You have to keep in mind that most industries last for fifty or sixty years. Their equipment doesn’t change that much. The only way to make a profit over the competition is to keep those machines running optimally.”

It’s not a good idea to do maintenance too soon, because then you would needlessly shut down business operations and make no turnover during that period, Kempen explains. But waiting too long isn’t a great option either, because then the machine might break down and you would have to pay twice as much. For the repairs and for the time that operations have stopped. The optimal maintenance moment for the machines can now be indicated with the help of sensors and AI.

Campione 2 is a program from World Class Maintenance, an organization dedicated to industry in the Dutch province of West Brabant. The program is subsidized by the Region of West Brabant, Midpoint Brabant, Region West-Brabt, the municipality of Tilburg, the Brabant Development Company (BOM), Rewin and the Dutch government. Entrepreneurs in the small and medium-sized business sector can call Van Kempen or his colleagues to make an appointment to discuss the application of AI in their production processes. They then pay them a visit to examine these and assess whether the application of AI is a worthwhile investment. If so, they will make a proposal that can be developed and tested in cooperation with specific technical consultancy agencies in the field lab.

Source: Innovation Origins

Free advice

The consultancy trajectory is usually free of charge, says Van Kempen. There is also a support program for entrepreneurs who want to apply AI in their manufacturing process. “We are working together with the Avans University of Applied Sciences to provide that assistance.”

5. TALENT AND EDUCATION, INCLUDING THE LABOR MARKET

A. General characteristics of Brabant's labor market

Brabant's workforce has proven to adapt easily to the cultures of foreign companies and multilingualism is the norm. Over 94% of the labor force has conversational knowledge of a second language, with English (90%), German (71%), and French (29%) being the most common. At least three-quarters of the population speaks two languages, aside from Dutch, and a third are competent in four languages. Two world-class universities (one offering technical studies, the other economics and law) and numerous universities of applied sciences guarantee a steady influx of new talent into the province.

LABOR FORCE IN BRABANT 2019

Brabant 1,396,000 people, or 15.1% of the Dutch population
The Netherlands 9,267,000 people 100%

LABOR FORCE BY GENDER AND AGE

Sex	Breda region	Tilburg region	Den Bosch region	Eindhoven region	Brabant	Participation rate
Male	183,000	141,000	194,000	232,000	750,000	76.9%
Female	160,000	123,000	169,000	193,000	645,000	67.7%
Total	343,000	265,000	364,000	425,000	1,396,000	72.4%

Age	Breda region	Tilburg region	Den Bosch region	Eindhoven region	Brabant	Participation rate
15-24	55,000	46,000	59,000	68,000	227,000	73.7%
25 - 44	131,000	104,000	136,000	171,000	542,000	89.5%
45 -74	157,000	115,000	168,000	186,000	626,000	61.8%

Source: Statistics Netherlands, 2020

LABOR FORCE BY GENDER AND AGE

	Secondary education (prevocational or general secondary education)	Secondary vocational education (vocational secondary education)	Higher professional education (university of applied sciences)*	Higher professional education (university of applied sciences)*
Breda region	36,980	15,690	See Brabant Total	70
Tilburg region	24,820	17,640	See Brabant Total	15,730
Den Bosch region	36,950	22,880	See Brabant Total	.
Eindhoven/Helmond region	43,420	22,280	See Brabant Total	11,970
Brabant	**142,170**	**78,490**	**86,910**	**27,770**

* Data for universities of applied sciences unavailable at sub-regional level due to mergers between these institutions, which means data only available at consolidated group level, and universities of applied sciences have campuses in multiple regions

Sources: DUO, 2019

Unlike many other countries, the Netherlands offers multiple forms of secondary education, giving children the opportunity to choose their path based on their talents and interests. The Netherlands has an excellent system of lower, secondary, higher, and professional education. The World Economic Forum's Global Competitiveness Report ranks the Netherlands third in the world, as evaluated by business leaders, based on the quality of education and training systems.

GRADUATE SKILLS LEVELS

	Ranking	Graduate skills
1	Switzerland	81.4
2	Finland	77.0
3	Netherlands	74.4
4	Singapore	73.4
5	United States	71.2
6	Luxembourg	71.1
7	Denmark	71.0
8	Qatar	70.9
9	Austria	70.8
10	Iceland	70.1

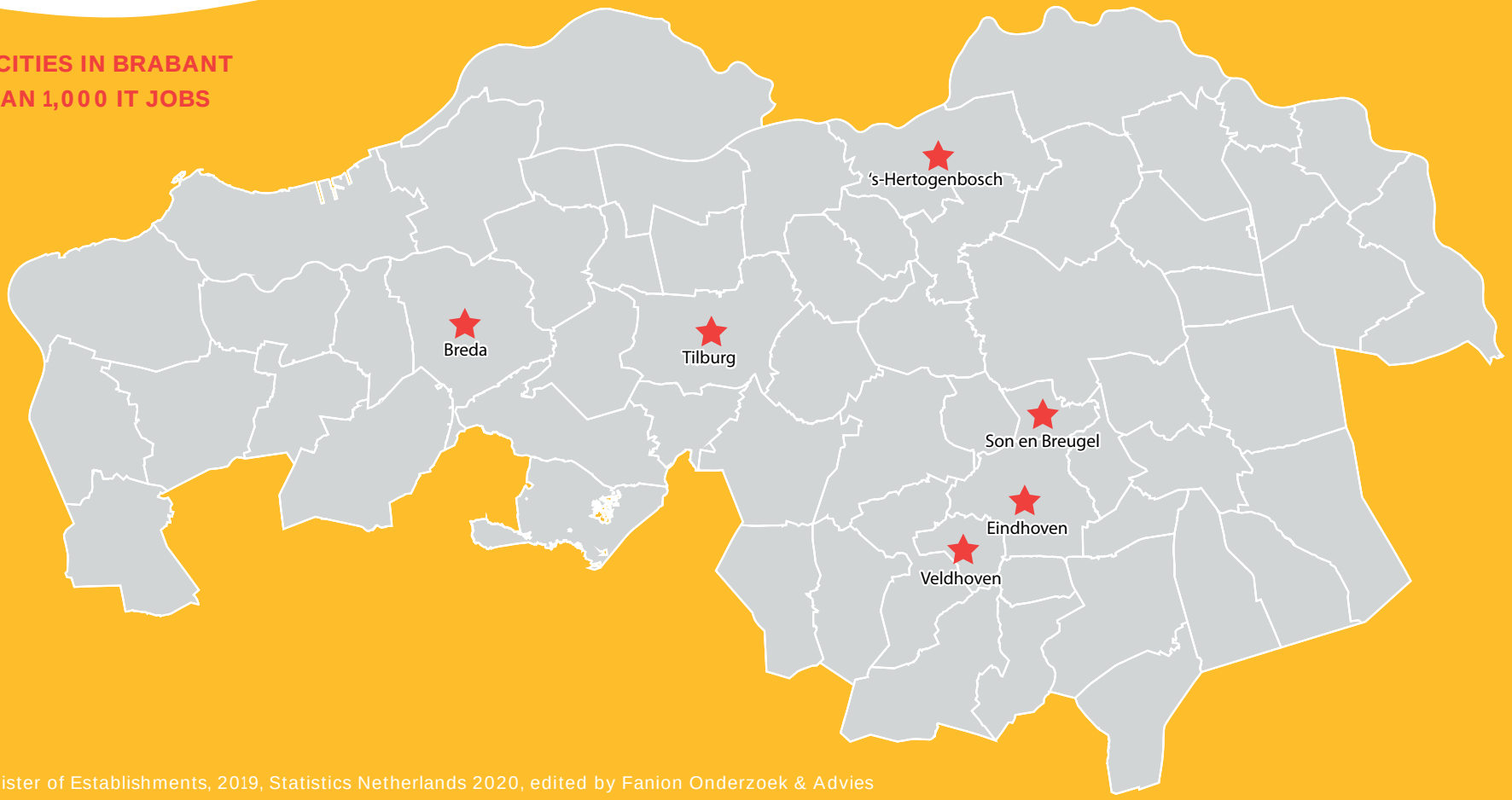
Source: World Economic Forum, the 2019 Global Competitiveness Report

B. Brabant's IT & Data Science labor market

This subindustry is divided into the following subsections:

- Current employment in the IT sector;
- IT professionals
- Students and graduates
- Unemployed

REGIONS AND CITIES IN BRABANT WITH MORE THAN 1,000 IT JOBS



Source: Brabant Register of Establishments, 2019, Statistics Netherlands 2020, edited by Fanion Onderzoek & Advies

1. CURRENT EMPLOYMENT

As stated in Chapter 1, 42,630 people in Brabant are currently employed in the IT sector. The Eindhoven/Helmond region (i.e. southeast Brabant, including the cities of Veldhoven and Son en Breugel) has the largest share at 17,050 people, followed by the Den Bosch region (northeast Brabant). The fact that IT is a knowledge-intensive sector is evident from the large proportion of highly-educated personnel, with almost 55% of the workforce highly educated. In the Den Bosch and Breda regions, that figure actually exceeds 55%. The average level of education for the employees in the Tilburg (mid-Brabant) and Eindhoven/Helmond regions (southeast Brabant) is a slightly lower, possibly reflecting the fact that IT activities in these regions are more inclined towards hardware manufacturing.

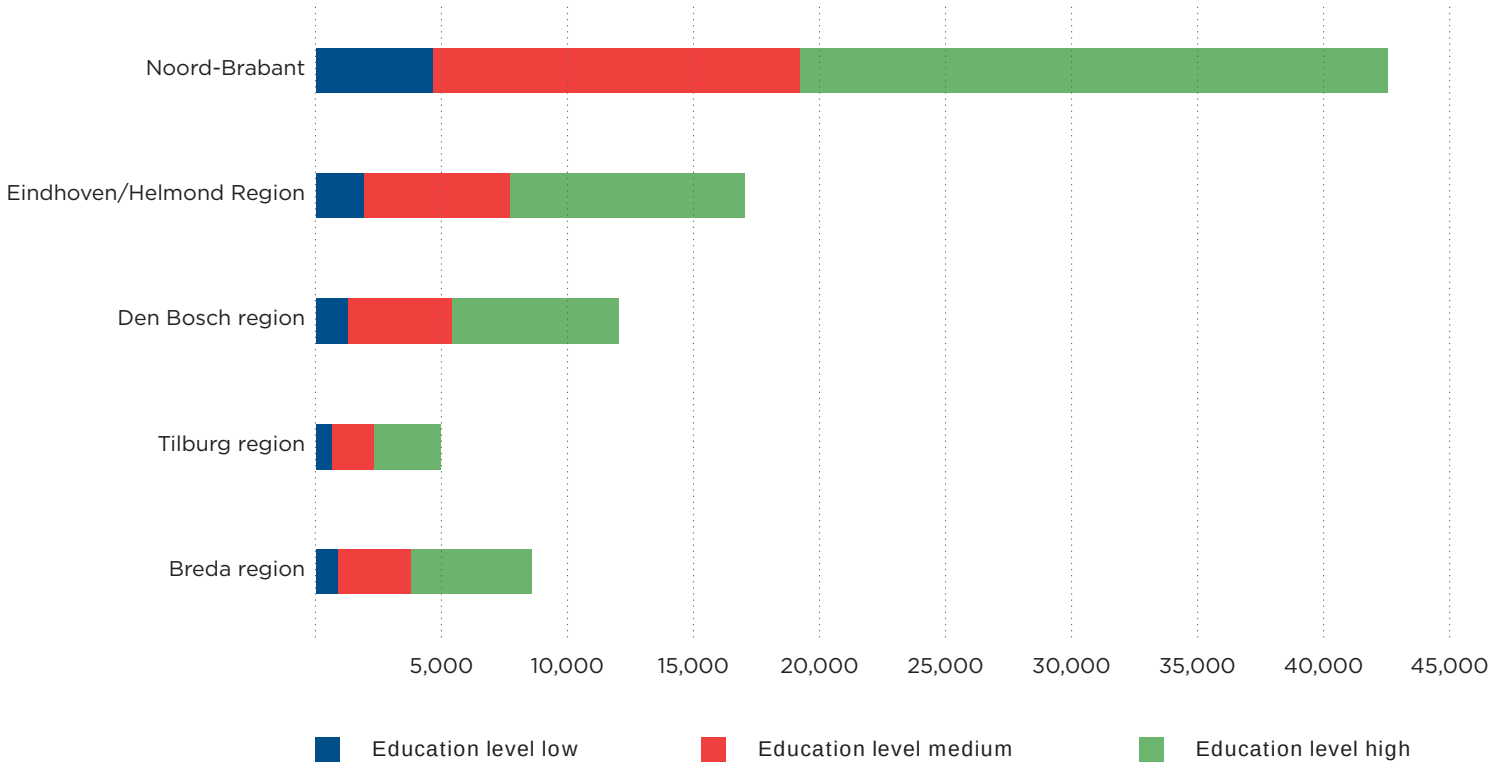
IT JOBS ACCORDING TO LEVEL OF EDUCATION, 2019

		Education level			
Regions	**Total**	**Low**	**Medium**	**High**	**Unknown**
Breda region	8,580	900	2,890	4,770	50
Tilburg region	4,950	600	1,700	2,640	30
Den Bosch region	12,050	1,250	4,130	6,650	70
Eindhoven/Helmond region	17,050	1,910	5,800	9,290	100
Brabant	42,630	4,670	14,530	23,340	240

		Proportion according to education level			
Regions	**Total**	**Low**	**Medium**	**High**	**Unknown**
Breda region	100%	10.5%	33.7%	55.6%	0.6%
Tilburg region	100%	12.1%	34.4%	53.2%	0.6%
Den Bosch region	100%	10.4%	34.2%	55.2%	0.5%
Eindhoven/Helmond region	100%	11.2%	34.0%	54.5%	0.6%
Brabant	100%	10.9%	34.1%	54.8%	0.6%

Source: Brabant Register of Establishments, 2019, Statistics Netherlands 2020, edited by Fanion Onderzoek & Advies

IT JOBS ACCORDING TO LEVEL OF EDUCATION, 2019



Source: Brabant Register of Establishments, 2019, Statistics Netherlands 2020, edited by Fanion Onderzoek & Advies

1. Characteristics of IT professionals in Brabant

Seventy percent of IT professionals in the Netherlands do not work in the "traditional" IT sector. In Brabant, 43% of professionals are employed outside that traditional IT sector. According to the Statistics Netherlands, there are a total of 74,000 IT professionals in Brabant.

Brabant's talent pool is brimming over with a large variety of skills, with the most common IT & Data Science skills shown in the image on the right:

THE UNIQUE SKILLS OF BRABANT'S TALENT POOL COMPARED TO OTHER DUTCH REGIONS:

Research using the LinkedIn talent insights database, which consists of data from around 6.9 million users in the Netherlands (73.3% of total labor force), shows that the skillset of the IT talent pool is Brabant is closely linked to the prominent high-tech sector in the region.

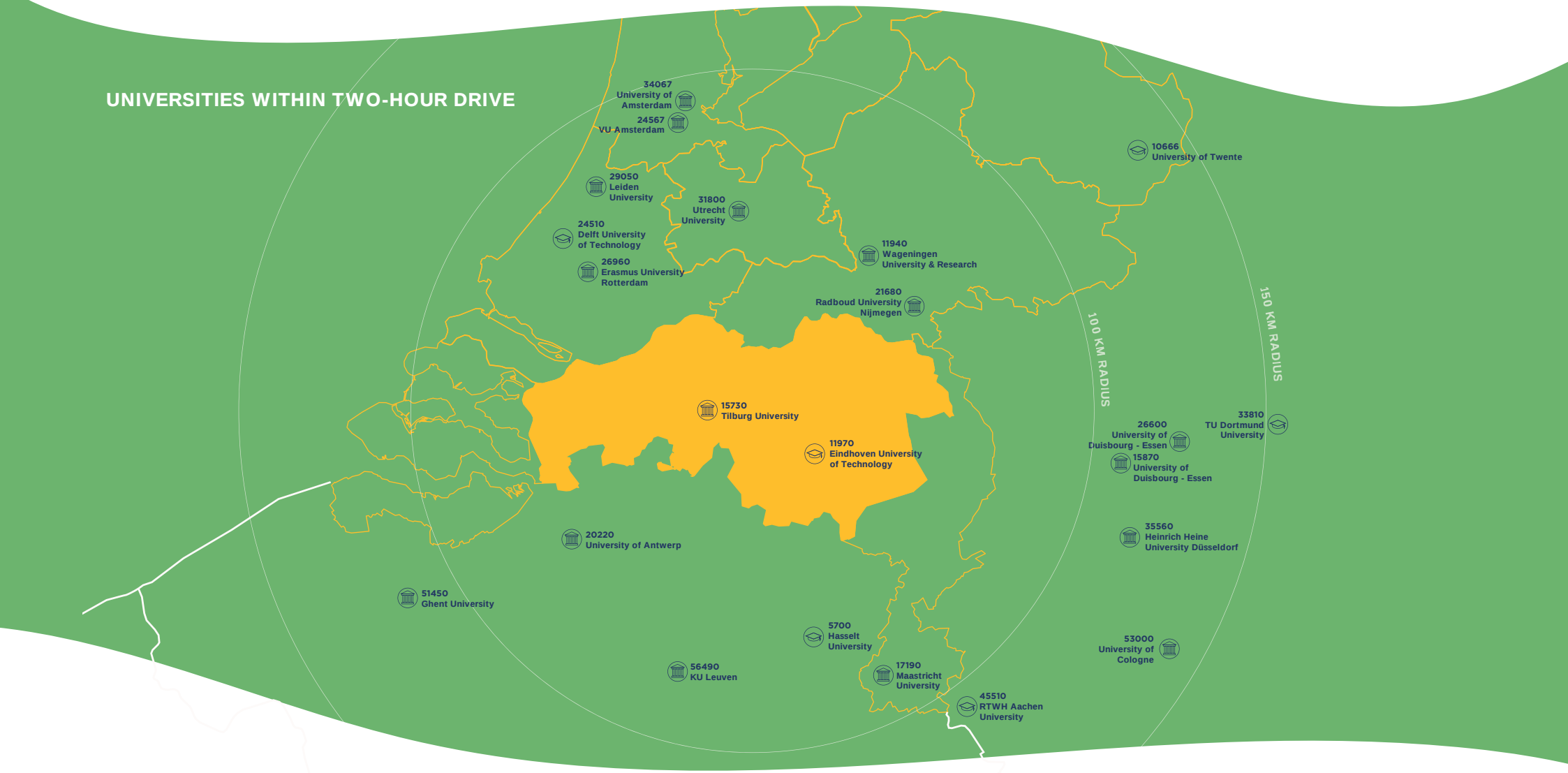
THE BRABANT REGION HAS THE HIGHEST NUMBER OF TALENTED PEOPLE IN THE NETHERLANDS WITH THE FOLLOWING SKILLS:

- Embedded software
- Embedded systems
- SAP software
- Software design
- Simulation
- Automation
- Robotics/Robot programming
- Low level programming
- Assembly language programming
- Real time operating systems
- Ada programming
- Algorithm development

Source: LinkedIn Talent Research - 2021

UNIVERSITIES WITHIN A 150 KILOMETER RADIUS

Within a radius of 150 km (about a two-hour drive) of the center of Brabant, there are 22 universities, of which eleven are general universities, five are universities of technology and six are specialized in other fields. The total student body numbers 605,340 students, of which there are at least 255,680 studying for a natural science, health, or technology degree.



City	University	Driving distance	Type of university	Number of students	Natural Science, Health and Technology students
Tilburg	Tilburg University	0	Specialized university	15,730	460
Eindhoven	Eindhoven University of Technology	0	University of technology	11,970	11,900
Nijmegen	Radboud University Nijmegen	80 km	General university	21,680	7,090
Utrecht	Utrecht University	90 km	General university	31,800	13,580
Rotterdam	Erasmus University Rotterdam	90 km	Specialized university	26,960	3,830
Delft	Delft University of Technology	110 km	University of technology	24,510	23,900
Wageningen	Wageningen University & Research	110 km	Specialized university	11,940	11,840
Maastricht	Maastricht University	110 km	Specialized university	17,190	5,590
Leiden	Leiden University	130 km	General university	29,050	6,390
Amsterdam	VU Amsterdam	130 km	General university	24,570	10,060
Amsterdam	University of Amsterdam	130 km	General university	34,070	8,960
Enschede	University of Twente	180 km	University of technology	10,670	7,650
Total, the Netherlands				**260,140**	**111,250**
Hasselt	Hasselt University	70 km	Specialized university	5,700	3,330
Antwerp	University of Antwerp	90 km	General university	20,220	9,310
Leuven	KU Leuven	110 km	General university	56,490	29,110
Ghent	Ghent University	150 km	General university	51,450	23,360
Total, Belgium				**133,860**	**65,110**
Duisburg	University of Duisburg - Essen	130 km	General university	15,870	
Dortmund	TU Dortmund University	130 km	University of technology	33,810	33,810
Aachen	RTWH Aachen University	130 km	University of technology	45,510	45,510
Essen	University Duisburg - Essen	140 km	General university	26,600	
Düsseldorf	Heinrich Heine University Düsseldorf	140 km	General university	35,560	
Cologne	University of Cologne	170 km	General university	53,000	
Total, Germany				**210,350**	**79,320**
Total number of students				**604,340**	**255,680**

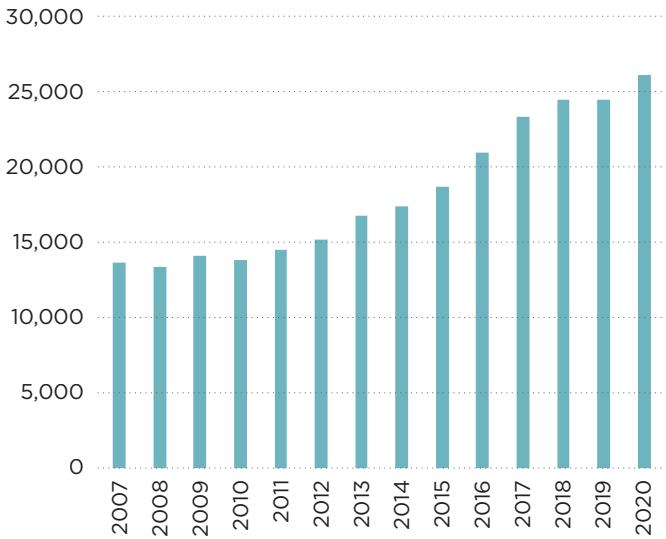
Source: DUO, Dataloep Vlaanderen, DEStatis/Statisisches Budesambt (2019), edited Fanion Onderzoek & Advies

2. IT education: students and graduates

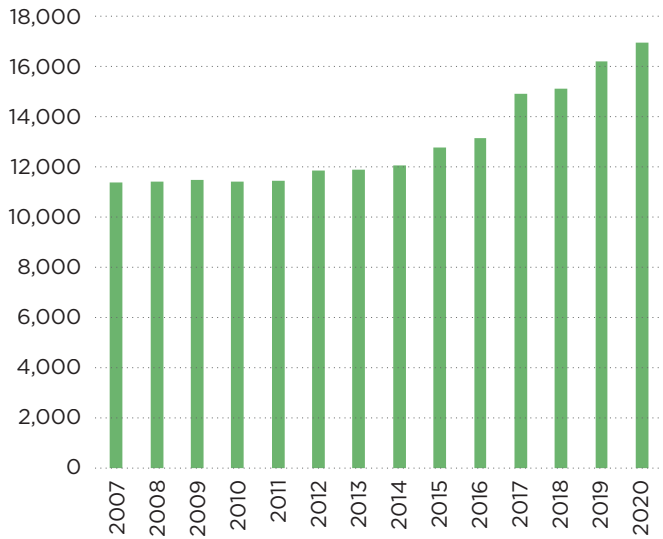
Starting in 2010, there was a significant rise in IT students in the Netherlands, with that trend also evident in the outflow (graduation) of IT students.

In 2020, over 26,000 students commenced on an IT related course, seven percent more than in 2019. In the same year, almost 17,000 students completed an IT related course.

New IT students Netherlands



IT Graduates Netherlands



Source: CA-ICT (2021) Expertisecentrum Digitalisering ICT. With data from DUO and CBS data.

IT GRADUATES IN THE NETHERLANDS AT ALL EDUCATION LEVELS.

Within the Netherlands, there are three regions where most of the IT talent is educated, with Brabant the second-largest.

Province	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
South Holland	2,448	2,438	2,344	2,200	2,186	2,418	2,354	2,500	2,522	2,694	3,317	3,262	3,452	3,443
Brabant	**1,777**	**1,663**	**1,790**	**1,803**	**1,819**	**1,925**	**1,899**	**2,037**	**2,197**	**2,360**	**2,660**	**2,779**	**3,151**	**3,410**
North Holland	1,832	1,944	2,120	2,188	2,033	2,059	2,061	2,104	2,303	2,330	2,525	2,643	2,965	3,151
Overijssel	1,322	1,312	1,186	1,114	1,256	1,268	1,112	1,243	1,177	1,186	1,223	1,351	1,375	1,506
Utrecht	871	867	848	826	799	880	1,126	1,193	1,316	1,220	1,235	1,365	1,378	1,466
Gelderland	879	840	891	912	991	1,040	1,063	997	1,080	1,164	1,435	1,322	1,369	1,354
Groningen	681	821	810	821	800	840	793	712	775	782	928	956	948	1,110
Limburg	700	604	588	717	632	582	565	507	582	567	588	558	643	657
Friesland	487	477	491	443	457	496	483	394	535	512	624	512	540	518
Flevoland	189	165	182	152	199	129	161	142	101	103	130	123	152	147
Zeeland	132	106	113	116	133	126	151	134	101	124	130	132	130	114
Drenthe	140	172	119	115	136	79	137	108	77	103	112	126	99	91

Source: CA-ICT (2021) Expertisecentrum Digitalisering ICT. With data from DUO and CBS data.

BRABANT IS THE LARGEST SUPPLIER OF IT TALENT WITH HIGHER EDUCATION DEGREES IN THE NETHERLANDS.

Because of the large and steady growth of new IT students, the Brabant region is now the number-one province in Netherlands when it comes to higher education IT graduates.

Province	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Brabant	**1,021**	**981**	**1,041**	**1,070**	**1,024**	**1,189**	**1,183**	**1,244**	**1,437**	**1,547**	**1,693**	**1,866**	**2,200**	**2,495**
South Holland	1,308	1,356	1,286	1,242	1,238	1,428	1,240	1,418	1,409	1,567	1,822	2,017	2,271	2,330
North Holland	853	908	949	1,002	937	1,077	953	1,116	1,307	1,384	1,543	1,716	1,877	2,080
Overijssel	646	677	607	592	627	671	556	627	634	580	677	753	814	906
Utrecht	538	591	592	571	554	621	719	739	722	738	723	845	874	898
Gelderland	327	308	347	362	336	444	451	469	512	557	645	681	712	779
Groningen	358	464	464	487	471	501	441	422	500	486	502	635	592	748
Limburg	294	289	245	252	214	236	233	208	254	311	235	254	324	355
Friesland	166	171	185	174	178	222	158	146	189	212	251	252	274	238
Zeeland	42	37	32	33	14	29	25	28	22	25	21	22	23	15
Flevoland	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Drenthe	32	21	23	18	15	0	0	0	0	0	0	0	0	0

Source: CA-ICT (2021) Expertisecentrum Digitalisering ICT. With data from DUO and CBS data.

IT & DATA SCIENCE GRADUATES BY UNIVERSITY:

	University	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY	**Technical University Eindhoven**	124	140	178	171	187	183	185	192	202	268	279	349	483	499
TILBURG UNIVERSITY	**Tilburg University**	298	202	235	203	287	373	364	370	382	358	420	482	645	781
JADS Jheronimus Academy of Data Science	**Jheronimus Academy of Data Science (JADS)**	*No data available for JADS													

IT & DATA SCIENCE GRADUATES BY UNIVERSITY OF APPLIED SCIENCES:

	University of applied sciences	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
avans university of applied sciences	**Avans University of Applied Sciences**	320	365	305	305	232	288	311	296	391	384	405	394	415	472
Breda University OF APPLIED SCIENCES	**Breda University of Applied Sciences**		2		9	14	19	50	62	95	132	188	175	164	165
Fontys University of Applied Sciences	**Fontys University of Applied Sciences**	310	304	348	406	332	326	273	324	367	405	401	466	493	578

Source: CA-ICT (2021) Expertisecentrum Digitalisering ICT. With data from DUO and CBS data.

IT & DATA SCIENCE GRADUATES BY UNIVERSITY OF APPLIED SCIENCES:

	Senior secondary vocational institution	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	Koning Willem I College	148	126	154	113	136	122	134	137	144	128	138	145	144	131
	ROC Ter AA	63	76	67	59	85	78	101	105	96	107	102	73	91	79
	ROC Tilburg	97	92	79	73	91	78	73	81	84	109	84	111	118	101
	ROC West-Brabant	213	181	206	232	195	206	166	196	191	223	245	213	236	213
	ROC de Leijgraaf	96	107	102	138	138	126	113	132	126	97	210	144	142	133
	SintLucas							20	17	19	27	24	33	31	26
	Summa College	139	100	141	118	150	126	109	125	100	122	164	194	189	232

Source: CA-ICT (2021) Expertisecentrum Digitalisering ICT. With data from DUO and CBS data.

JOBSEEKERS

There are also IT-related jobseekers. While the unemployment rate in the Netherlands is presently at a very low level, in mid-2020 there were still 710 unemployed IT professionals in Brabant. Of this group, 14% and 40% had low to mid-level education, respectively, while 45% were highly educated.

IT JOBSEEKERS, 2020

	Education level			
	Low	**Medium**	**High**	**Total**
Breda region	25	70	60	155
Tilburg region	20	65	55	140
Den Bosch region	25	55	70	150
Eindhoven/Helmond region	30	95	140	265
Brabant	**100**	**285**	**325**	**710**

Source: Employee Insurance Agency (UWV), 2020

6. LOCATION, CAMPUSES AND FACILITIES

Location

1. BRABANT, THE NETHERLANDS: YOUR GATEWAY TO EUROPE

In geographic terms the Netherlands – and Brabant in particular – has historically been the key port of entry to mainland Europe.

This is also true in a literal sense, as Brabant is part of the delta stretching between Rotterdam (Europe's largest port) and Antwerp (the continent's second largest port) and three of Western Europe's busiest airports: Amsterdam Schiphol, Brussels Airport and Dusseldorf International Airport. Excellent infrastructure (by road, rail, water and air) and IT and data communication networks that are second-to-none anywhere in the world are added bonuses.

This combination of strengths helps industry in the area to fluidly reach 170 million consumers in a radius of 500 kilometres (300 miles). These consumers with significant financial means (north-western Europe is one of the wealthiest markets in the world) are all within 24 hours of Brabant.

Efficient logistics services empowered by **INNOVATION & COLLABORATION**

#1 ENTRY POINT
In Europe for overseas products

#1 LOGISTICS
Hub in Europe

COMPETITIVE COST
for labour, real estate and transport

500 km proximiy to European markets
170 MILLION CONSUMERS

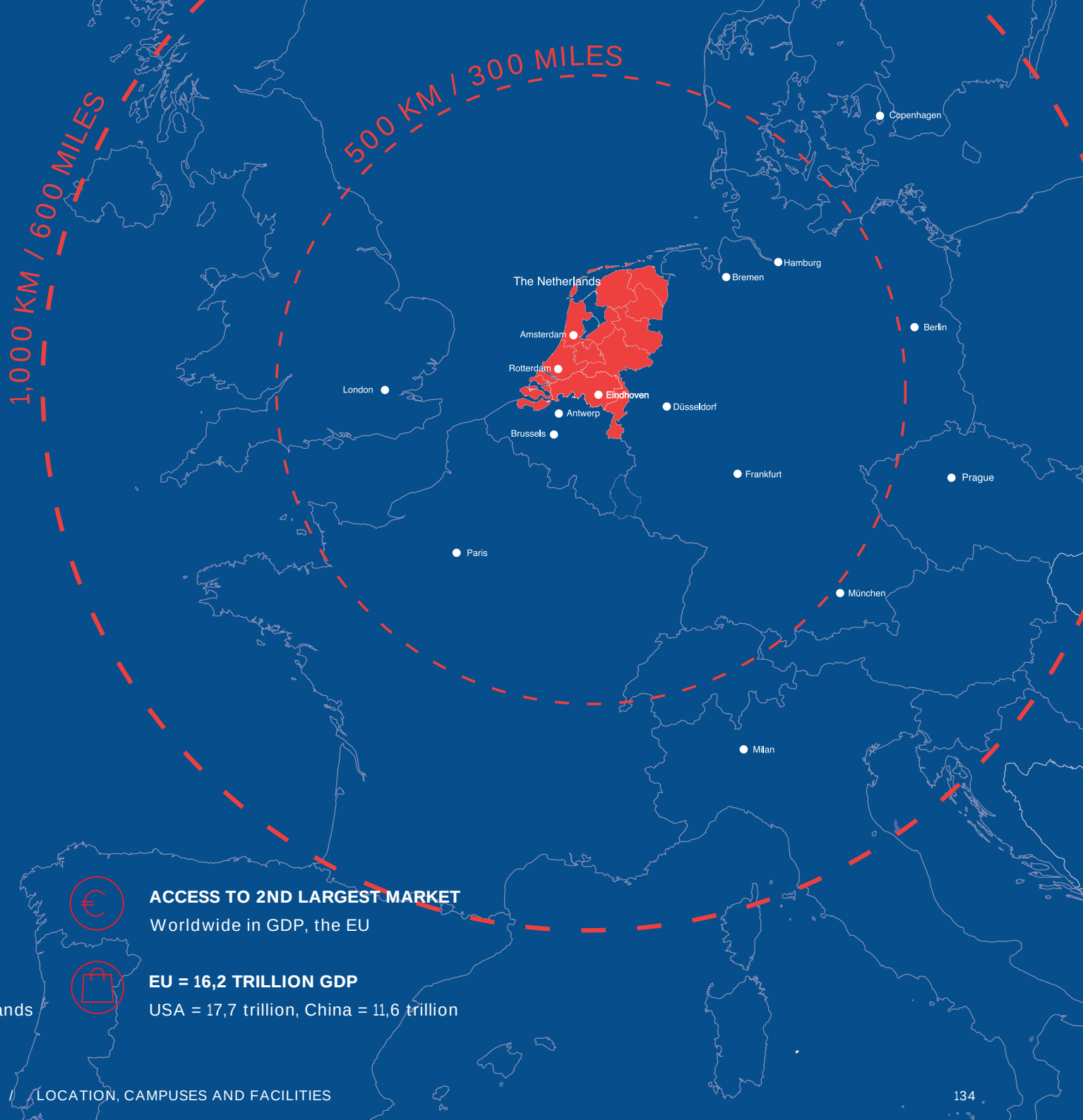
3 MAINPORTS
For air, data and sea

EXCELLENT CONNECTIVITY
To Europe and all continents

World class & competitive business environment
NO VAT PAYMENT AT IMPORT

2. BRABANT, THE NETHERLANDS: ACCESS TO THE SECOND LARGEST MARKET IN THE WORLD

Within a radius of 500 kilometres, businesses can reach 170 million consumers in Western Europe, and if that circle is extended to a radius of 1,000 kilometres (600 miles) – still within easy and rapid reach – this figure grows to 250 million people. The largest European economies – Germany, France, the United Kingdom and the Benelux region – are all within a day's reach. The rest of the European Union (the second largest market in the world in GDP terms) is just as accessible from Brabant, with an additional 24 to 36 hours in transit time.



170 MILLION CONSUMERS
Within a 500 km / 300 mile radius

250 MILLION CONSUMERS
Within a 1,000 km / 600 mile radius

PERFECT SPRINGBOARD
into European market

MAJOR EUROPEAN ECONOMIES
are within a day's reach of the Netherlands

ACCESS TO 2ND LARGEST MARKET
Worldwide in GDP, the EU

EU = 16,2 TRILLION GDP
USA = 17,7 trillion, China = 11,6 trillion

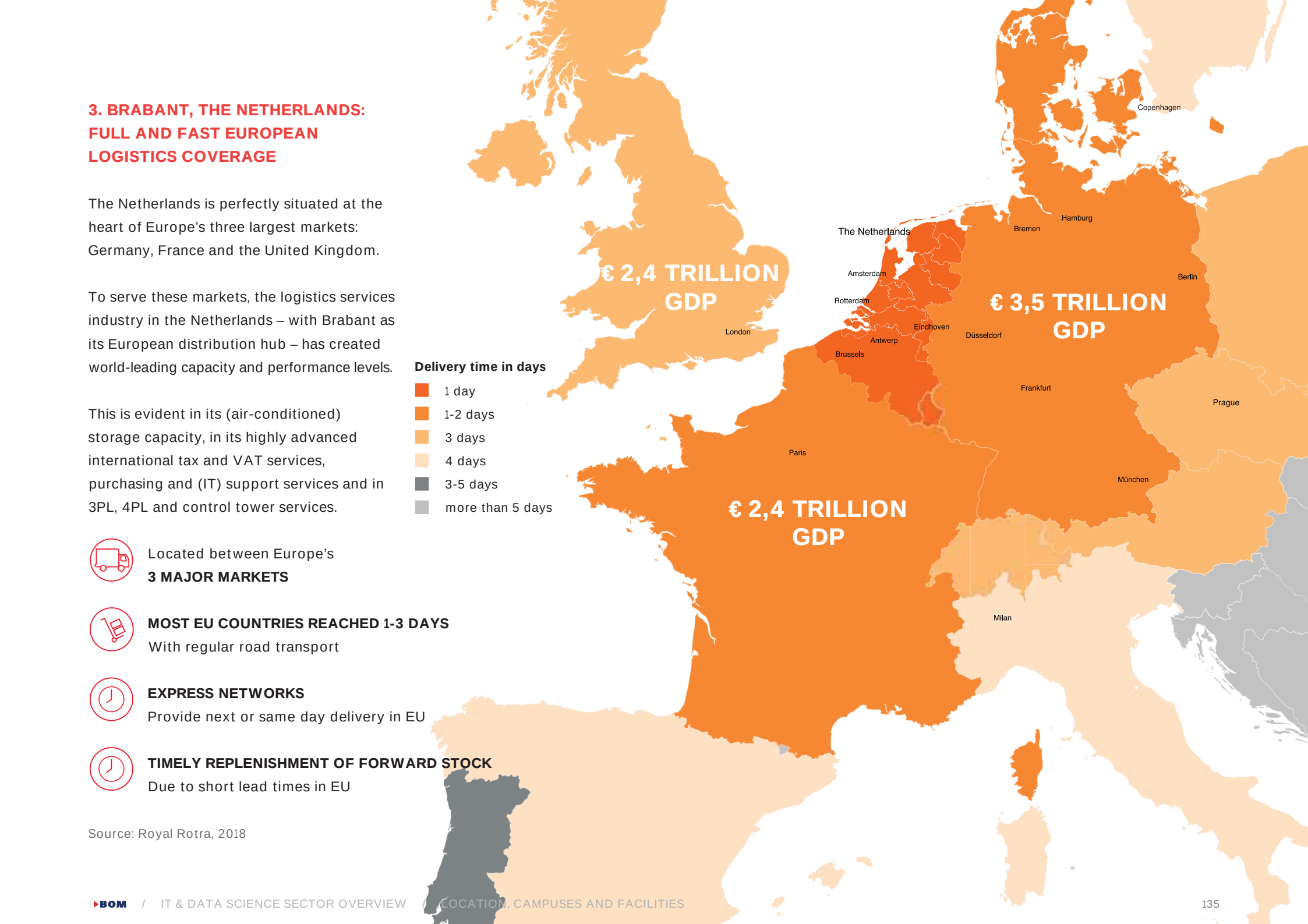
Source: Invest in Holland, 2018

3. BRABANT, THE NETHERLANDS: FULL AND FAST EUROPEAN LOGISTICS COVERAGE

The Netherlands is perfectly situated at the heart of Europe's three largest markets: Germany, France and the United Kingdom.

To serve these markets, the logistics services industry in the Netherlands – with Brabant as its European distribution hub – has created world-leading capacity and performance levels.

This is evident in its (air-conditioned) storage capacity, in its highly advanced international tax and VAT services, purchasing and (IT) support services and in 3PL, 4PL and control tower services.



Located between Europe's **3 MAJOR MARKETS**

MOST EU COUNTRIES REACHED 1-3 DAYS
With regular road transport

EXPRESS NETWORKS
Provide next or same day delivery in EU

TIMELY REPLENISHMENT OF FORWARD STOCK
Due to short lead times in EU

Source: Royal Rotra, 2018

B. Campuses and facilities

There are several IT Campuses and facilities in Brabant . The map below charts those business locations where at least 250 people are employed in IT positions. Of the locations with over 250 IT positions, the cities of Den Bosch and Eindhoven lead the field.
The largest locations are De Hurk in Eindhoven (1,840 jobs), De Herven in Den Bosch (1,760 jobs), De Brand in Den Bosch (1,360 jobs), Ekkersrijt in Son en Breugel (1,280 jobs) and Flight Forum (1,270 jobs).

In addition to these business locations, there are a number of campuses that provide excellent ecosystems for IT companies:

Campuses	Location
Mariënburg Campus	Den Bosch
De Grasso	Den Bosch
Eindhoven University of Technology campus	Eindhoven
High Tech Campus	Eindhoven
Strijp-S	Eindhoven
Strijp-T	Eindhoven
MindLabs	Tilburg
Brainport Industries Campus	Eindhoven
Automotive Campus	Helmond
Gate 2	Rijen

BUSINESS LOCATIONS WITH A LEAST 250 POSITIONS IN IT COMPANIES

Business locations	City
Breeven	Best
Hoogeind	Breda
Maaspoort	Den Bosch
High Tech Park	Den Bosch
De Rietvelden	Den Bosch
De Herven	Den Bosch
De Brand	Den Bosch
GDC Eindhoven Acht	Eindhoven
Eindhoven Airport/ Flight Forum	Eindhoven
De Hurk	Eindhoven
High Tech Campus	Eindhoven
Esp	Eindhoven
Dombosch	Geertruidenberg
Haansberg/Aeroparc	Gilze-Rijen
De Dubbelen	Meierijstad
Ekkersrijt	Son en Breugel
Diepenvoorde	Waarle

Source: Register of Establishments, 2019, IBIS 2018, QGIS, edited by Fanion Onderzoek & Advies

A. High Tech Campus

High Tech Campus Eindhoven is the smartest square kilometer in Europe, with over 200 companies and institutions, and 12,000 researchers, developers, and entrepreneurs working on developing future technologies and products. The Campus helps companies to accelerate their innovations by offering easy access to high-tech facilities and international networks. Campus companies (such as Philips, NXP, TomTom, Shimano, Signify, IBM, and Intel) decide, on a strategic basis, what knowledge, skills, and R&D facilities to share in order to achieve faster, better and more customer-oriented innovations in the fields of health, energy, and smart environments. Located in the heart of Brainport, Campus companies account for nearly 40% of all Dutch patent applications.

OPEN INNOVATION

The High Tech Campus is famous for its concept of open innovation, which sees companies working together and having shared access to high-tech facilities and international networks.

HIGH TECH CAMPUS EINDHOVEN

LARGEST EMPLOYERS

Philips and NXP are by far the largest employers at High Tech Campus, responsible for around two-thirds of all jobs on the Campus.

Top 10 largest employers at High Tech Campus		
#	Name	Jobs
1	Philips – Corporate Technologies High Tech Campus	> 5,000
2	NXP Semiconductors	> 500-800
3	TMC Mechatronics B.V.	100-200
4	Signify Research	100-200
5	TNO	100-200
6	Teledyne DALSA B.V.	100-200
7	VDL ETG Research B.V.	50-100
8	Holst Centre Stichting IMEC Nederland	50-100
9	Lumileds	50-100
10	IBM Nederland NV	20-50

Source: Brabant Register of Establishments, 2018

INSTITUTES

Crucial to the open innovation concept of High Tech Campus are the research institutes, as they bring together companies and the fundamental research conducted by TU/e, TNO, and others. The following institutes are present.

Knowledge institutes	
Institutes	Activity
5G Hub	An eco-system of municipalities, politics, companies, start-ups, and education and knowledge institutes to increase the quality of life and the economic appeal of Brainport Eindhoven through new technologies (such as 5G, AI, VR/AR, blockchain, and photonics) and innovative applications
ARTEMIS Industry Association	Embedded intelligent systems
Biotech Systems Platform	The Biotech Systems Platform aims to widely publicize and stimulate innovation and collaboration between biotechnology, life sciences and the domain of high-tech systems and equipment
ECN	R&D for sustainable energy systems
TU/e	Eindhoven University of Technology
EIT Digital	Innovation in and education on digital transformation
Holst Center	Generic technologies for wireless autonomous sensors and for flexible electronics
Imec	Imec is a world-leading R&D and innovation hub in nanoelectronics and digital technologies
ITRI	R&D on information and communications, electronics and optoelectronics, advanced manufacturing, biomedical and devices, material and chemicals, and energy and the environment
ITEA	Software intensive systems and services
PhotonDelta	Ecosystem to accelerate integrated photonics solutions
Solliance	Development of thin film photovoltaic solar energy
SEAC	Solar Energy Applications
TNO	Scientific Research

Source and more info: https://www.hightechcampus.com/

RESEARCH AND INDUSTRIAL FACILITIES

The High Tech Campus has several technical and research facilities available.

These facilities are all hosted by Philips Innovation Services and Eurofins.

Institutes	Activity
Signify Electromagnetic Compatibility & Wireless Connectivity lab	Profound and accurate testing, consultancy, and certification in the fields of: • Electromagnetic compatibility (EMC) • Wireless approbation • Wireless robustness (multipath performance, total radiated power, antenna diagrams) • Electrical safety **Focus on:** Lighting, medical, semiconductors and IoT/RF products and systems www.hightechcampus.nl/faciliteiten/signify-emc-wireless-connectivity-lab
Philips Innovation Services	• Prototyping • Instrumentation service • Measurements • Technical support and consultancy www.hightechcampus.nl/faciliteiten/philips-innovation-services
Philips Research Eindhoven	• Physics, chemistry, electronics, mechatronics, embedded software, signal processing, and computer science for cross-disciplinary fields like biomedical engineering, microbiology, biophysics, and systems design through to psychology, perception, and behavioral sciences. One of those departments that plays a large role in IT is the Philips Research Digital Twin Department www.philips.com/a-w/research/home
Eurofins: Material analysis lab	**Services:** • Chemical analysis and physical inspection of materials and objects • Contamination control • Chemical compatibility - enabling suitable material selection, specifications, and process optimizations • Material reliability - resolving reliability issues, quality control support, failure analysis • Glass characterization • Analytical methodology (design of tests, experiments, and data analysis) **Areas of expertise:** • Compositional analysis • Surface and thin-film characterization • Advanced imaging • Physical characterization www.hightechcampus.com/facilities/eurofins-material-science-material-analysis-lab

Source and more info: https://www.hightechcampus.com/

Institutes	Activity
Eurofins: Reliability lab	A complete package in reliability testing services **Environmental Simulation:** • High/low temperature • Temperature and humidity • Power temperature cycling (PTC) • Thermal cycling • Thermal shock • HAST/corrosion testing • Solar/UV simulation **In-situ test service:** • LED lifetime (optical output) • Event detection (low resistance) • Monitor (I/V/L/R vs. time) **Highly Accelerated Lifetime Test (HALT):** • HALT test • MEOST test **Mechanical test service:** • Bump and shock • Drop test and free fall (mechanical and simulation) • Surface affection • Waterproof pressure test • Drawbench and tensile test **Water Vapor Transmission Test (WVTR):** • Calcium test on thin-film barriers www.hightechcampus.com/facilities/eurofins-material-science-labs-reliability-lab

Source and more info: https://www.hightechcampus.com/

THE AI INNOVATION CENTER

The AI Innovation Center is a brand-new open innovation facility at the High Tech Campus Eindhoven. Its mission is to accelerate the application of data science and artificial intelligence technologies by companies in the larger Brainport Eindhoven area.
The Center is an initiative of the High Tech Campus Eindhoven and was co-founded by Brainport Eindhoven giants Philips, ASML, NXP, and Signify. It aims to drive the adoption of AI by companies of all sizes, improving the regional economy and society at large.
To achieve this mission, the AI Innovation Center brings together technology companies, platform and service providers, research and educational institutes, and other relevant ecosystem partners in a shared facility.

The AI Center focuses on:

- Providing an AI ecosystem and infrastructure
- Accelerating AI projects and applications
- Hosting AI events and education

AI ecosystem and infrastructure

The AI Innovation Center is an open ecosystem for large companies, startups, SMEs, research and educational institutes, and service providers. All activities are focused on stimulating organizations to apply data science and AI technologies.

AI projects and applications

The AI Innovation Center, together with its partners, helps companies to get off the ground in applying AI. Whether it is a startup or SME that wants to get more out of its data, or a mature data science and AI technology company looking for the right talent to execute a project, the AI Innovation Center is the place to find solutions.

The AI Innovation Center is also the place to be for AI application demos to a broad audience. Conveniently located in the heart of the High Tech Campus Eindhoven, on The Strip, the Center has all the amenities to showcase a company's skills.
For the most promising startups, the AI Innovation Center offers an incubation period of six months – a soft landing spot. During this period, the startups get (flexible) office space in the Center and access to all relevant knowledge and partners in the ecosystem.

Events and professional education

Knowledge-sharing is a vital aspect for the open innovation culture at the High Tech Campus Eindhoven. The AI Innovation Center builds on this tradition, driving and facilitating knowledge-sharing on AI-related topics. The Center hosts open sessions to get people and organizations onto the learning curve or to keep experienced professionals updated on the latest developments in AI.
A professional education portfolio is being prepared with partners.

OTHER FACILITIES

Next to high-tech research and companies, the High Tech Campus offers numerous facilities, such as banking, shopping, exercise, car rentals, restaurants, a conference center, and childcare

Other facilities at the High Tech Campus

Company	Facility
ABN AMRO	Financial services
Venture Capital Desk	Financial services
Albert Heijn to go	Supermarket
Driessen Mobility Center	Car rental
Campus Wellness Center	Sport and wellness
Campus Sports	Exercise
Conference Center HTC	Conference center
Canon Business services	Copy and printing service
De Boerderij	Social events
Driessen Mobility Center	Services for cars
Yask Facility Management	Facility management
Bicycle repairer	Bicycle repairer
Fysio Company Care	Physiotherapy
Nemo Kinderstad	Daycare
IAK	Insurance

Company	Facility
GGD	Vaccinations/health
Science Hair	Hairdresser
Alfresco	Restaurant
Brave New World	Restaurant
Daely	Restaurant
Grand Café	Restaurant
LOKL	Restaurant
Love my curry	Restaurant
Okinawa	Restaurant
Subway	Restaurant
FoodLab - Food Trucks	Restaurant
The Lounge	Restaurant
The Mart	Restaurant
Tlab	Restaurant
Eurest Management Services	Management services

Source and more info: https://www.hightechcampus.com/

B. TU/e Campus - Eindhoven University of Technology

The TU/e Campus is an open and accessible community for technology education, scientific research, and commercializing knowledge. It is a lively hotspot in the Brainport Region of Eindhoven, bringing together students, researchers, entrepreneurs, and high tech companies. The green TU/e campus is fast becoming an attractive hotspot for students, researchers, entrepreneurs, investors, and high-tech companies, thanks to its state-of-the-art offline and online facilities. The campus is a site under development but is already a green and lively spot in the heart of Eindhoven

- Company accommodation - Apart from the university, around a hundred companies and organizations are also located on the campus, from large research institutes to smaller startups. The TU/e campus aims to be a place where these parties connect, which is why a range of different spaces are available.
- Living on campus - The campus has 700 apartments for (international) students and people working on the campus.
- Congress and conferencing facilities - The campus has excellent facilities for hosting congresses, while different rooms can be rented for smaller meetings and for conferencing.

TU/e EINDHOVEN UNIVERSITY OF TECHNOLOGY

FACTS AND FIGURES TU/E

- 121 hectares
- Over 13,000 students
- 5,000 knowledge workers
- 90 nationalities
- 14 unique research labs
- 100 companies and organizations
- 700 apartments
- 10 Eateries
- 70 sports facilities

Source and more info: www.tue.nl/tue-campus/

COMPANIES AND INSTITUTES ON THE TU/E CAMPUS

More than a hundred 100 companies and research institutes are located on the TU/e Campus, besides the TU/e body itself. Most of them are active in engineering, technical design, and consultancy. The largest organizations of these are the TNO research institute and GE Healthcare Life Sciences Core Imaging (formerly Medical Diagnostics).

THE TEN LARGEST ORGANIZATIONS ON THE TU/E CAMPUS

Organization	Activity	Jobs
TNO	Research and development on technology	100-200
GE Healthcare	Production of radiopharmaceutical products	100-200
Syntouch International	Business intelligence/ICT	20-50
Micro Turbine Technology	Manufacture turbines	10-20
Polymer Technology Group Eindhoven	Development of polymers	10-20
42 Solutions	Software developments	10-20
Magna View	Software developments	10-20
Cytomate Technologies	Medical equipment	10-20
SyMO-Chem	Research and development on chemicals	10-20
AccTec	ion beams for the production of radionuclides	10-20

C. BIC - Brainport Industries Campus

Brainport Industries Campus (BIC) is a unique location for high-tech manufacturing.

The most innovative and successful companies and institutions in the Brainport region come together as one on the Brainport Industries Campus. The campus is where the innovative and competitive strengths of the high tech manufacturing industry take shape. Leading knowledge institutes and renowned companies work together at the Brainport Industries Campus in order to accomplish ideas and develop business cases. This is where the next generation of professionals in the high tech manufacturing industry is trained in a state-of-the-art working and learning environment. Brainport Industries Campus is the place to be for far-reaching partnerships between suppliers, specialist companies, and innovative education and knowledge institutes.

Brainport Industries Campus is the very first location where high-tech suppliers innovate and manufacture together, where the most successful companies share high-quality facilities, such as cleanrooms, flexible production areas, warehouses, and other advanced facilities, and where they showcase themselves as a unified force to their national and international customers.

Brainport Industries Campus

Source and more info: www.brainportindustriescampus.com/en/

Brainport Industries Campus today

- Over 35 companies
- 2,000 high-level staff
- 1,500 students
- 105,000 m^2
- 6,000 m^2 of shared facilities
- 6,000 m^2 of shared logistics

Some of the current tenants are: ABAB Groep, Additive Center, AM Flow, AMS, Anteryon, Avans University, BG Legal, BOM, Brainport Development, Brainport Industries, Ceratec, Cordis Suite, Exploitatiemaatschappij BIC, Festa Solutions, Festo, Fluke Europe, Fontys University, Fujitsu Glovia, Full Fact, High Tech Software Cluster, IJsel, ITAM Solutions, K3D, Kieu Engineering, KMWE, KPN, Macroscoop, MakerPoint, Marketiger, Procureon, Province North-Brabant, RUBIX, Siemens, Sodexo, Solar Team Eindhoven, Summa School of Professional Education, TBP, Techpro, and Yaskawa.

There is also the Data Value Center (DVC-SI) at BIC, which aims to help companies create added value and become more competitive through the use of data. BIC DVC-SI provides support to entrepreneurs, decision-makers, and professionals when it comes to the optimal use of data – process optimization, developing new services and revenue models, and furthering the required knowledge and competences.

DVCSI

D. Automotive Campus Helmond

Automotive Campus is an initiative of the partner companies in AutomotiveNL and the community of Helmond. Other partners are BOM, Brainport Development, Driven, Helmond City of Smart Mobility, the Ministry of Economic Affairs, Agriculture and Innovation, the Netherlands Foreign Investment Agency, and the Province of Brabant.
Automotive Campus provides a home for companies, institutes, educational bodies (high school and higher vocational students in automotive technology) as well as public and private research centers and test facilities in the field of automotive technology and smart mobility. It provides a challenging and inspiring environment where knowledge and business come together in the spirit of cooperation, knowledge sharing, and open innovation. The Campus also functions as the knowledge center for the Brainport Eindhoven, a top technology region and a one-stop shop for research, engineering, and testing. In anticipation of future trends, Automotive Campus focuses on two major technology domains – green mobility and smart mobility. Other areas of focus include integrated safety, design, and manufacturing and process management.

The Automotive Campus in Helmond is an open innovation ecosystem and aims to be the Dutch hotspot for research and development, design, modeling, engineering, testing, and assembly and production in the field of automotive technology, with a focus on green and smart aspects.

Source: https://innovationorigins.com/

Key Figures

- 110,000 m² Offices, workshops, and labs
- 140,000 m² still to be built
- 620 engineers and research specialists
- 600 automotive students at all education levels
- 45 companies and organizations
- 25 labs and test facilities
- 100 events per year
- 10,000 visitors per year

KNOWLEDGE INSTITUTES

Both knowledge and educational institutions can be found at the Automotive Campus.

Knowledge and educational institutions	
Knowledge institutes	**Activities**
Automotive Center of Expertise	Connecting research institutes with companies
DITCM Innovations	Connecting research institutes with companies
European Centre for Mobility Documentation (ECMD)	Projects related to mobility documentation and automotive
FEV Group	Knowledge on automotive development
UAS Fontys	University of Applied Science
De Innovatiecentrale	Innovation lab for smart traffic systems
De Car Academy	Vocational education center
NCAD Nederlands Centrum voor Autohistorische Documentatie	Historic documentation on cars
Summa Automotive	Vocational education organisation
TNO	Scientific Research
RDW	Dutch national vehicle authority
Innovam	Automotive education

Source and more info: www.automotivecampus.com/

COMPANIES

There are over 15 companies at the Automotive Campus. The largest are Altran Engineering, TASS International, and VDL ETS.

Overview companies		
Companies	**Activity**	**Country**
Altran Engineering	Design and engineering services for the automotive industry: e-mobility, ADAS, prototyping, testing	France
Tass International	Testing, crash testing, traffic technology	Germany
Lightyear	Solar-powered electric cars	Netherlands
VDL ETS	Development and testing transport systems	Netherlands
KPN	5G field lab in combination with smart mobility	Netherlands
2 get there	Autonomous vehicle projects	Netherlands
Durapower	Battery systems for electrical vehicles and energy storage	Singapore
V-tron	Fleet management systems	Netherlands
Fier Automotive	Business development agency specialized in automotive matters	Netherlands
InMotion	Developing the race car of the future	Netherlands
Jumbo Groenewegen	Trailers	Netherlands
Automan	Human resources in automotive	Netherlands
Vehant Technologies	AI-based security products	India
Spike	High-quality and flexible battery solutions	Netherlands
Electric Motorbikes	Innovative electrical motorbikes	Netherlands
XYZ Dynamics	Engineering services for electrical vehicles	Netherlands
Goodmoovs	App for sharing electrical vehicles	Netherlands
Dens	Sustainable engines powered with formic acid	Netherlands
Saluqi Motors	Electric drive systems with integrated power electronics	Netherlands

Source and more info: www.automotivecampus.com/

INSTITUTIONS

Name	Focus	Jobs	Industrial partners
Automotive Center of Expertise	Connecting research institutes with companies	6	13 including DAF, VDL, Bosch Transmission Technology, and Mitsubishi
De Innovatiecentrale	Innovation lab for smart traffic systems	12	-
DITCM Innovations	Connecting research institutes with companies	-	14 including NXP, Sweco, CGI, Siemens, and TASS International
European Centre for Mobility Documentation (ECMD)	Projects related to mobility documentation and automotive	1	-
Nederlands Centrum voor Autohistorische Documentatie	Historic documentation on cars	1	-
SmartwayZ	Knowledge institute for smart mobility	-	NXP, Jan de Rijk Logistics
TNO Automotive	Automotive research: powertrains, integrated vehicle safety	110	48 including Volkswagen, Volvo, Nissan, Ford, Scania, Honda, Fiat, and Peugeot.
UAS Fontys: Automotive	Operating systems, electronic systems, and drivetrains powertrains, also the reduction of the emissions of engines and vehicle dynamics	-	-

SHARED FACILITIES

The Automotive Campus Shared Facilities provide high-tech automotive testing facilities and spaces for research, offices, and workspace for a wide range of bodies, including SMB, knowledge and educational institutions.
The facilities serve to bolster the Dutch automotive industry and the Brainport region and are the result of a partnership between Altran Engineering Services, construction company Van de Ven, TNO, TASS International, and VDL.
The partnership received support from the Ministry of Economic Affairs, the Province of Brabant, SRE ,and the municipality of Helmond.

Source and more info: www.automotivecampus.com/

TEST AND INDUSTRIAL FACILITIES

The Automotive Campus houses various high-quality technical facilities that serve a range of purposes. Many research laboratories and test facilities form part of the Automotive Campus Shared Facilities, while others are owned by testing and research companies such as the TNO, TASS International, and Altran.

There are a number of test centers at companies associated with the Campus:

Facility	Activities
TNO Powertrain Center	• Powertrain testing • Climate altitude chamber
TASS: Safety Center	• Full scale crash testing • Inverse crash sled • Laboratory for pedestrian and interior protection and components • Road furniture • Vehicle dynamics • Homologation
TASS: ADAS Testing	• Autonomous Emergency Braking – Car to Car • Autonomous Emergency Braking – Vulnerable road users • Lane support systems • Advanced Emergency Braking
TASS: Automated Driving Validation	• Virtual testing • Mixed reality testing • Real world testing
TASS: International Mobility Center	• DITCM test site • DITCM control room • DITCM car labs • Simulation tool suite • Laboratory testing
Altran: Testing services & Facilities	• Low frequency testing • High frequency testing • Climate • Corrosion • Final inspection lab • Custom-built test rigs
VDL: Rolling Road Testbench	• Engine performance tests • Specific speed profile tests • Suspension fatigue tests • Fuel consumption tests • Road load simulation • Ambient temperature test
Hydrogen Fueling Station	• Hydrogen generator
Traffic Innovation Center	• Innovation lab and innovation expertise

Source and more info: www.automotivecampus.com/

CAMPUS COMMUNITY

Being part of the Automotive Campus means being part of a very complete and beneficial network. Scientists, engineers, and students come together in a culture of open innovation, creating the ideal environment for new partners and new ideas.

It's all about driving together – the Automotive Campus stimulates the exchange of knowledge and offers activities and state-of-the-art facilities. In short, the Automotive Campus is the place to be for business and R&D, with everything close at hand, and that means a company has every chance of succeeding.

E. Mariënburg Campus, Den Bosch

A national monument since 1897 and the former monastery and motherhouse of the Sisters of the Society of Jesus, Mary and Joseph, the Mariënburg Campus is located in the bustling city of Den Bosch, or Den Bosch , a stone's throw from the central station. Since 2016, it has been the home of Den Bosch's first university, the Jheronimus Academy of Data Science (JADS). In addition to the university, more than 3500 m^2 of office space is available for data science-related companies, from startups to digital SMEs. The campus also has 77 furnished apartments. Studying, working, and living under one roof – a unique concept in the Netherlands.

Companies at Mariënburg Campus are:

- Celonis
- Vivat
- Underlined
- Green Gorillas
- Hello New Day
- Gymeyes
- KPN
- eComPro
- Dataspox
- Vereniging Nederlandse Gemeenten
- Adchieve
- Rockstart
- InvoiceFinance
- Dutch Institute for Technology Safety and Security

mariënburg campus

Source and more info: https://marienburgcampus.nl/

F. Strijp-S

Strijp-S was once a Philips industrial complex that has been transformed over four phases into a working and residential neighborhood. The project started in 2005 and will continue until 2030, and the plan features the following:

- 92,000 m^2 of industrial and office space
- 2,500-3,000 homes (290,000 m^2)
- 60,000 m^2 of facilities (restaurants, designer clusters, shopping, culture, and creative industries);
- 135,000 m^2 gross floor space for (national) monuments;
- 5,000 m^2 (built) parking spaces.

The 27 hectare area is characterized by its high urban diversity, with many residents, hundreds of new businesses, and more than a million visitors a year. Almost 600 companies are located in the area, over 130 of them in the Ateliers, and most are engaged in creative activities. Strijp-S is quickly developing into the creative hotspot of Eindhoven.

OFFICE BUILDINGS

The main office buildings are the Apparatenfabriek (the "Equipment Factory') and the Klokgebouw (the "Clock Building'), office blocks that focus on the creative industry, including designers, architects, interior decorators, communications specialists, photographers, consulting engineers, publishing companies, music centers, concept developers, graphic companies, and other creatives. In addition, concert, dance party, festival, and exhibition organizers use the very large event halls in the Klokgebouw.

DUTCH DESIGN FOUNDATION

The Dutch Design Foundation is a platform for designers and design-driven companies, organizations, and research institute in the Brainport Eindhoven region. The Dutch Design Foundation encourages and connects creative initiatives to strengthen the country's national and international reputation in the field of high tech and design. All projects developed by or with the organization aim to make a visible contribution to the improvement of the economic, cultural, and sociopolitical climate.

SMART CITY STRIJP-S

Concepts are explored in the Strijp-S smart city in a living lab environment. The Strijp-S smart city concept consists of three layers.

1. The "cloud layer" houses all data and online traffic. Analysis, communication, and content development all take place in this layer
2. The "livable layer": the tangible part of the city, the streets people walk on and the door handles they touch
3. The "infrastructure layer": roads, railways, pipes, and optical fiber cables

The interaction between these layers makes the city smart. The layers communicate with each other and work together, thus creating crossovers and integrations. The result means a more efficient and sustainable city with opportunities for innovative business models.

Source and more info: https://strijp-s.nl/

G. Strijp-T

Innovation, renewal, and acceleration are all part of the DNA of Strijp-T. Philips has achieved great successes here and it is the birthplace of spinoffs such as NXP and ASML. With a long-standing foundation in the high-tech manufacturing industry, Strijp-T is the cradle of the Brainport region. Its controversial history is palpable, and it is where new technologies are still being developed and where ideas come to life.
The impressive post-war buildings have been renovated, with respect for atmosphere and architecture, and optimized for sustainable business.
By applying modern construction and installation techniques, an energy-efficient, sustainable, safe, and comfortable complex has been created with a characteristic industrial look.

Strijp-T is 26 hectares in size and houses six renovated buildings that are available to rent.
There are already 40 companies and organizations at Strijp-T, including Thermo Fisher, Kragt Groep, Draka Comteq Fibre, Signet, and Fontys UAS's IT Innovation Lab. The companies and organizations at Strijp-T aim to work together to form an innovation district with an open innovation environment.

STRIJP·T

INNOVATION DISTRICT

Source and more info: www.strijp-t.nl

H. Grasso

Grasso is a historical building in the center of Den Bosch. Founded in 1858, the company gained national fame with its margarine industry machinery, and later, cooling machines, and compressors. In the 1950s, Grasso opened branches in other cities in the Netherlands and abroad.

The building is the middle of the Spoorzone, between Jeroen Bosch Hospital and Brabanthallen, an upcoming area revolving around the city's Central Station. A range of businesses, restaurants and bars, and educational institutions are close by.

Grasso will become a new co-working concept in Den Bosch for startups, scaleups, and for established names, with a focus on IT and data science. The intention is to join forces as a Grasso community, to gain access to extra data, create new opportunities for innovation, and bolster Den Bosch as an important Dutch IT region.
IoT Stadslab (IoT City Lab), No Food Wasted, Marvelous, Collect + Go, Kresco Innovations, Arfected, Argaleo, Autofactor, CodeSharp, Helixers, Quiver, Maddox Media, Kyl, Rocketeer Internet Marketing, Trade Cover Exchange, and Avans University of Applied Sciences are all set to be a part of the community.
By mid-2021, startups, scaleups, and established names with a focus on IT will have the opportunity to be connected and productive in pleasant workspaces with reliable connectivity in a first-class location.
The Grasso building is being renovated in 2021. By keeping the focus on the building and using original Grasso elements, a coherent theme is being created where old meets new.

Source and more info: www.degrasso.nl/

I. Tilburg Spoorzone, MindLabs

The Spoorzone is a 75-hectare area in the middle of the city of Tilburg next to the train and bus stations. It was the stage of much industrial activity for over a century, and in 2010 the area was opened up once again. Today the Spoorzone is undergoing constant development – renovation, redevelopment, and new constructions create a varied mix of living and working space, educational institutes, cultural facilities, and bars and restaurants.

The Spoorzone is home to MindLabs, housed in an 8,500-13,000 m2 building. MindLabs is a collaborative initiative between the Fontys University of Applied Sciences (Department of Journalism), the ROC Tilburg vocational education institute, media and publishing company De Persgroep, the city of Tilburg, the Province of Brabant, and Tilburg University (Department of Cognitive Science & Artificial Intelligence). MindLabs is active in the field of interactive technologies and behavior, investigating human minds and artificial minds, and promoting an innovative mindset.

MindLabs focuses on four research themes:

1. The Robotics & Avatars Lab develops virtually intelligent avatars that can interact with humans
2. The Serious Games Lab develops and investigates opportunities to bring fun and learning together
3. The Natural Language Technologies Lab develops and tests computational linguistic algorithms to make computational sense out of human languages
4. The Virtual and Mixed Reality Lab investigates the intersection between our own world and simulated worlds.

MindLabs is located at Spoorzone in the city of Tilburg.

Source and more info: www.mind-labs.nl/mind-labs/

J. Aeroparc/Gate 2, Gilze-Rijen

Aeroparc, formerly known as the Ericsson site, is situated in a prime location right next door to the Gilze-Rijen Airbase. Aerospace and maintenance activities form the foundation of the park, hence the name Aeroparc. Aerospace & Maintenance is one of the social innovation spearheads of the province of Brabant and the network organisation Midpoint Brabant, and is expected to generate both economic and social added value for the region.
Aeroparc is conveniently located on the N282, the provincial road connecting Tilburg and Breda, and is within easy reach of the A27 and A58 motorways, as well as Gilze-Rijen railway station. The business park is 130,000 m^2 in size and boasts numerous green areas and free parking. It forms an important part of the redevelopment of the Gilze en Rijen railway area.

Gate2 is located at Aeroparc in Gilze-Rijen and offers accommodation to companies in the smart industry cluster. The focus was originally on the aviation and maintenance sector, but today Gate2 offers a full range of smart and flexible technologies: pilot training, world class maintenance, composites, big data, Internet of Things, 3D printing, sensor technology, adaptive robots, augmented and virtual reality, and interactive avatars.

All activities, capabilities, and companies at Gate2 can be classified into principal spearheads:

1. Simulation
2. Production technology

Source and more info: www.aeroparc.eu/

SIMULATION

The simulation activities are as follows:

Facility	Activities
Air Mobility Training Center (AMTC)	At Gate2, the Air Mobility Training Center (AMTC) has been developed for training air force pilots for the KDC10 and C130. Simulator training has become essential, and the simulators here are D-type, the highest class. The crew can replace flight hours with simulator hours, which means an hour on the simulator is equivalent to an hour of training in an airplane. Two simulator sessions are available each day for crews.
Adrenaline control	Adrenaline Control combines cutting-edge sports science services, state-of-the art simulator technology, and a unique training approach through a driver maturity model and a professional infrastructure into a blended one-shop training organization for open wheel and GT motorsport racers and teams. Trainees at Adrenalin Control have one common goal: to improve and excel at peak performance on demand and under-pressure.
BlueTea	Training aircraft maintenance engineers using virtual training simulations and serious games. Real-life situations are brought to life to increase the skills required for performing specific work, create awareness of existing risks and dangers, strive for maximum safety, and prevent mistakes/losses in practice.
Helios (Helicopter Instruction & Operational Support Flight Training Center)	Provides specialized helicopter training for both civil and military aviation. Helios uses simulators and an innovative training system in which pilots are trained by means of advanced simulation flights in a sustainable, noise-friendly, and cost-efficient manner.
Merlin Aviation	Merlin Aviation builds and sells professional static aircraft simulators. The Boeing 737 and the Airbus series are especially popular among pilots, who say the simulators are indistinguishable from the actual aircraft. The 180-degree view nearly perfectly matches the real-world situation. The panels, electronics, and software were all designed by Merlin Aviation.
VROOM Training	VROOM Training is specialized in immersive virtual reality, where you are immersed in the virtual world. It is used to train mechanics and engineers in real-life situations.
DAF Technology Lab	The DAF Technology Lab provides high-tech facilities for students, researchers, and the business community. The combination of technology and behavioral sciences expertise offers unique possibilities for innovative teaching and research. The DAF Technology Lab consists of two spaces, the Experience Room, and the Research Room.

PRODUCTION TECHNOLOGY

The activities focusing on production technology are:

Facility	Activities
3D Printing Lab	Joint-innovation for the future manufacturing industry, that is the power of 3D Print Lab. It provides SMEs with a 3D printing facility so that they can get the 3D print and additive manufacturing technology in-house at a low investment threshold. 3D Print Lab provides access to knowhow, its experimental lab, and production space.
Campione	The CAMPIONE project is a field lab project with participants from the chemical and process industries from across the Netherlands. Several companies and institutions from central Brabant are also a part of it and play an important role in the project. The goal of the project is to make maintenance 100% predictable through advanced techniques that are at the cutting edge of condition-based maintenance and big data. New products and services will be created through the field lab that have export potential.
Composite Expertise Center	Training maintenance, repair, and overall (MRO) specialists in composites.
Daedelus Aviation Group	Daedalus is a global company in the maintenance, repair, and overhaul (MRO) sector. The company focuses on deploying onsite support teams for performing first and second-line maintenance, component maintenance, depot maintenance, modifications, and upgrade programs in the military aviation sector. Daedalus has a flexible database of fully qualified and certified maintenance technicians, all of whom have the required security clearances. The vast majority of their technicians have at least 20 years of experience in the field of MRO, especially for the F-16 weapons system, Apache AH-64, Chinook CH-47, and Cougar AS-532.
The Carbon Specialist	The Carbon Specialist focuses on repairing carbon applications. It is the first and currently the only company in the Benelux that repairs carbon applications for the private sector and that holds a Boeing repair certificate. Its specialty is repairing high-end racing and ATB frames, but the company also has experience with other carbon applications, such as car parts. The Carbon Specialist's repairs are guaranteed for life.
Glue Academy	Glue Academy works on partnerships with research centers, education, branch organizations, and companies active in the distribution and processing of glue and glue-related products. It performs a wide range of activities to promote the industry, including presentations at symposia, participating in trade fairs, and developing and supporting educational packages for primary and secondary school students.
MATinspired	MATinspired gives customers more technical insight into the materials of their product. The company does this by means of advice, damage research, workshops, material research, analyses, and the development of test kits.
Rotary Wing Training Center (RWTC)	The Rotary Wing Training Center (RWTC) trains helicopter fitters from all over the world to work on various types of helicopters, including Boeing and Airbus helicopters.
TiaT Europe	Threshold Inspection & Application Training Europe BV (TiaT Europe) has its roots in the aviation sector in the Netherlands. TiaT Europe specializes in non-destructive research (NDT).
Van Kempen Engineering & Consultancy (KEC)	Van Kempen Engineering & Consultancy offers leading consultancy, project, and interim management to players in innovative and high-tech markets. Aerospace is one of the markets in which KEC operates.

Source and more info: www.gate2.nl

7. COOPERATION IN BRABANT AND NETWORKS (BUSINESS, SCIENCE, GOVERNMENT)

INTRODUCTION

Brabant has a distinctly strong culture, history, and tradition of informal constructive partnerships that are based on trust and "open innovation'. This is particularly evident in the following respects, along with numerous others:

- The fact that some of Brabant's largest companies (VION, Cosun/ SuikerUnie, FrieslandCampina) have a history of working together.

- The century-old roots of some of the region's industrial giants and the fact that these companies are completely intertwined with the development of the region, the cities, the universities, the schools, housing, leisure, the football clubs, and so on (Philips in Eindhoven, MSD via Organon in Oss, MSD Animal Health through Akzo/Intervet and Hendrix in Boxmeer).

- The fact that Philips decided, 17 years ago, to open up its originally hermetically-sealed NatLab research site in Eindhoven and began to invest in "open innovation" by inviting other companies to join in. The company invested hundreds of millions of euros in further developing the campus and facilities to optimize joint research, the result being the Philips High Tech Campus. The site, located in the middle of Eindhoven and home to 12,000 researchers from over 200 companies and institutes from around the world, is now owned by a property investor and named the Eindhoven High Tech Campus (HTCE). Key tenants remain Philips Healthcare, Philips Research and Signify (formerly Philips Lighting) as well as NXP, ASML, Holst Centre and Xeltis.

- The concept (joint research, shared facilities, intensive cooperation, and significant outsourcing when it comes to drug discovery and development) and success of the Pivot Park biopharmaceutical campus in Oss. The advantages of this culture are that cooperative ventures, both informal and highly intensive, are ingrained in the area. Many CEOs in the region, mayors and city councilors, and academics will frequently say, "the door is always open, so don't hesitate to drop by", "we make the best decisions sitting at the kitchen table", and "we know each other's mobile phone numbers and we pick up the phone whenever we see a friend is calling".

In short: building partnerships in the region is a quick and fluid process – and faster than anywhere else in the Netherlands. Outsiders who wish to join the club and make an actual contribution will quickly and easily reap the rewards.

CONNECTING GLOBAL GIANTS: BRABANT'S INDUSTRIAL ICONS

In Brabant a number of key ingredients have been fruitfully mixed together for over a century, creating one of the strongest high-tech systems regions in the world:

- Entrepreneurship
- Corporate social responsibility
- Cooperation and open innovation
- Roots in AgriFood and Health
- Strong regional pride and loyalty, but with a focus on a global market

The growth of three remarkable Brabant business families in the past century exemplifies and characterizes how this region developed to attain its current strong position and open approach to working and partnerships. Three extraordinary individuals started businesses here that developed into three connected clusters of companies, consisting of dedicated tier 1 and 2 suppliers, dedicated logistics service providers, and renowned research centers all the way through to certification bodies and a number of global multi-billion dollar OEM companies.

These three individuals were Frederik Philips, Saal van Zwanenberg, and Wim Hendrix.

- Frederik Philips built a modest light bulb factory in 1891 in Eindhoven
- Saal van Zwanenberg founded a slaughterhouse for export in 1887 in Oss
- Wim Hendrix started selling chickens in Boxmeer in 1916

They all started out small, some on their own. But their businesses grew, flourished, diversified, and have been entering new markets ever since. And, in the process, the parent companies have bred hugely successful subsidiaries and spinoffs:

- Frederik founded Philips, today's Royal Philips (Healthcare), a global 18 billion euro-company with 74,000 employees that also gave birth to other icons, such as ASML, FEI Company, Thales, and NXP, all of them still headquartered in the region or with their global research centers based in the province.
- Saal started Zwanenberg, which became Organon and then Chefaro, and is part of today's MSD (Merck) that focuses on human health and specializes in pharmaceutical and biological research and manufacturing, including one of the world's latest cancer treatments, Keytruda (pembrolizumab).
- Wim started selling chickens to farmers, after which his entrepreneurial spirit saw companies born that grew to become Hendrix Genetics, MSD (Merck) Animal Health (formerly Intervet), Nutreco, and Marel Poultry.

All of these companies still have their headquarters and/or significant research and innovation operations in Brabant, employing thousands of highly-trained professionals.

And around them, the full value and supply chains in their core businesses developed, flourished, and grew, resulting in a region that is now home to three priority industries:

- High-tech Systems & Materials, with over 15,500 companies and nearly 130,000 employees
- Life Sciences & Health, with over 900 companies and more than 18,000 employees
- AgriFood, with close to 14,000 companies and more than 80,000 employees

Today, industry and science in Brabant in these sectors still leads the way, but cross-overs are also increasingly occurring between the three, with new solutions being developed in areas such as:

- Imaging, monitoring, and guided surgery
- Big data and smart algorithms in animal husbandry
- Vision and sensor technology for welfare monitoring
- Needle-free, intradermal vaccination devices
- Flying cars
- Electric cars fueled only by solar panels
- Indoor farming systems
- New cooling technologies for ICs and data centers
- Communication technologies using lasers
- Direct air capturing of CO_2
- Hydrogen fueling systems and processing technology
- Precision farming using drones and satellites
- Autonomous weeding robots
- And many, many more

A. National networks for IT and Data Science:

1. NLdigital

NLdigital is the trade association for IT and telecom companies in the Netherlands, representing the industry's interests when dealing with the authorities and political world. Over 600 IT companies in the Netherlands are members, 80% of which are small and medium sized enterprises, but also including the biggest IT companies in the Netherlands.

NLdigital's activities aim to create the best possible business environment for IT companies in the Netherlands, and it works in close cooperation with organizations such as the Confederation of Netherlands Industry and Employers (VNO-NCW) and the FME (the employers' organization for the technology industry). Digital Europe in turn represents the industry's interests in Europe. A strong trade association is crucial for the entire industry, and a strong IT industry is critical for Dutch business as a whole.

NLdigital's approximately 600 members are active in all branches of information and communications technology, from telecommunications to IT hardware, from customized software to cloud applications, from consultancy to data centers, and from applied gaming to app development.

NLdigital is dedicated to achieving the best business environment for IT companies. It promotes the interests of the IT industry as a whole and in specific areas. New issues become hot topics through developments such as the cloud, Big Data, the Internet of Things, robotics, and 3D printing. NLdigital discusses such issues with the government and other stakeholders. As the representative of IT companies, it is also the first point of contact for the media.

2. Dutch Digital Delta

Team dutch digital delta (DDD) identifies, prioritizes, and organizes digital research and innovation and creates ecosystems that tackle social and economic issues. It does this by bringing public and private parties together in innovation coalitions with, on the one hand, a focus on societal challenges and, on the other, a focus on key enabling technologies. Training new talent, knowledge dissemination, and international cooperation are an important part of its mission.

Team dutch digital delta's mission is to help the business community, public agencies, and knowledge institutes to create innovations through IT and to strengthen the international position of the Netherlands as an investment destination and through IT innovations. Tools used include partnerships, knowledge sharing, and funding concepts for specific themes.

Team dutch digital delta uses programs and initiatives to work in public-private partnerships with priority industry organizations, universities, knowledge institutes such as TNO, NWO, CWI, and the NLeSc center, several government ministries, industry organizations such as NLdigital, CIO Platform Nederland, FME, VNO-NCW/MKB-Nederland, and ECP | Platform for the Information Society, private bodies, and startups and scaleups.

DDD has defined the following social challenges and key technologies that it focuses on.

Social challenges	Key Technologies
1. Energy transition and sustainability	1. Big Data
2. Agriculture, water, and food	2. Blockchain
3. Health and Care	3. Artificial intelligence
4. Safety	4. Cybersecurity
	5. Future networks and services

Source and more info: https://dutchdigitaldelta.nl/

Upvoting platform of dutch digital delta:
Dutch digital delta has created an "upvoting platform" that SMEs can use to publish initiatives in the field of IT innovation, and research institutes can advertise for partnerships with companies for those same initiatives. In addition, dutch digital delta places challenges on the platform that companies and research institutions are invited to contribute to.

3. Nederlandse AI Coalitie (NL AIC, the Dutch AI Coalition)

he NL AIC's mission involves encouraging, supporting and, where necessary, organizing Netherlands-based AI activities. Its aim is to make the Netherlands one of the frontrunners in Europe and the world in the field of developing and applying AI to contribute to wellbeing and welfare in the Netherlands, with due regard of Dutch and European standards and values. This requires a collaborative approach, where the authorities, companies, educational and research institutions, and social organizations work together.

The Dutch AI Coalition focuses on the following common goals:

Placing knowledge, expertise, and results into five common building blocks for all areas of application:

- Human capital: the availability of sufficient talent (including retraining and further training)
- Research and innovation: developing new AI knowledge through scientific and applied research and making it optimally accessible to stakeholders
- Data sharing: facilitating the availability and sharing of data
- Social acceptance, frameworks, inclusion – achieving the social acceptance of AI by involving end-users in research, innovation, and applications, an inclusive approach, and in co-creating ethical, legal, and social frameworks
- Startups and scaleups: supporting AI-driven startups and scaleups in tapping and utilizing resources, data, and partners (matchmaking) for business development

Stimulating the coordination of roadmaps and action agendas in and across different areas of application and facilitating such. Sharing knowledge, experiences, and insights in and about different areas of application and building blocks, and between the areas of application and building blocks.

Source and more info: https://nlaic.com/

4. Dutch Blockchain Coalition

The Dutch Blockchain Coalition (DBC) is a joint venture between partners from government, knowledge institutes, and industry. DBC's mission is to promote reliable, robust, and socially accepted blockchain applications, create the best possible conditions to allow blockchain applications to be constructed, and utilize blockchain as a source of trust, welfare, prosperity, and security for citizens, companies, institutions, and government bodies. In respect of this mission, the DBC acts principally as a catalyst and facilitator that activates and connects within a broad public-private network.

The DBC has developed an action agenda that focuses on the following three lines of action:

- Developing blockchain building blocks: digital identities
- Creating the conditions for utilizing blockchain
- Developing and realizing the human capital agenda

The DBC will investigate this through the following experiments:

- Self-sovereign identity (SSI)
- Logistics
- Academic certificates and diplomas
- Pensions
- Compliance by design
- Mortgages

Source and more info: https://dutchblockchaincoalition.org/

5. Data Sharing Coalition

The Data Sharing Coalition is an open and growing national and international initiative in which a large variety of organizations collaborate on unlocking the value of cross-industry data sharing. The initiative was launched in January 2020, after the Dutch Ministry of Economic Affairs and Climate Policy asked market players to explore cooperation in pursuit of cross-industry data sharing. The Data Sharing Coalition, supported by the Ministry, was a direct outcome of that.

The Data Sharing Coalition aims to drive cross-industry data sharing, under control of the entitled party, by enabling interoperability between data sharing initiatives and strengthening individual initiatives. Several data sharing initiatives exist (as of 2020), and these often focus on a specific industry or domain. Examples include Initiatives such as HDN for the mortgage domain, MedMij for the healthcare domain, or SURF for the higher education and research domain. These initiatives facilitate data sharing for their participants. Additionally, generic initiatives such as GO FAIR, AMdEX, iSHARE, NEN, and the International Data Spaces Association provide overarching principles, standards, or functionalities that can be used in new and existing data sharing initiatives. The Data Sharing Coalition aims to build on these existing data sharing initiatives so that they can further unlock the value of data sharing in and across their domains.

Source and more info: www.datasharingcoalition.eu

6. Commit2Data

Big Data plays an increasingly important role in the innovation of services, products, work processes, and business models. The smart collection and use of data results in the further economic growth of the Netherlands. Commit2Data, a multiyear national research and innovation program based on public-private partnerships (PPP), was created to further develop the use of Big Data. Commit2Data focuses on the potential applications of Big Data and the new business models and opportunities that Big Data creates. In order to exploit this optimally, Commit2Data enhances knowledge and the valorization and dissemination of data, stewardship, and technology for the priority industries.

There are also a number of fundamental challenges for all key industries. For Commit2Data these are the horizontal-cutting-edge themes it focuses on:

- Data Handling: platforms, access, distributed solutions, privacy, security
- Data Analytics: machine learning, statistics, mining, efficient algorithms

A focused effort is needed to shift the boundaries of current data science and Big Data solutions, and to grow the algorithmic understanding of data semantics, computational complexity, data protection, and human information overload.

Commit 2 Data
connecting business and science

Commit2Data focuses on the following themes:

- Logistics
- Smart culture
- Energy
- Health
- Smart industry
- Data handling
- Sport and exercise
- eScience
- Agriculture
- Security

Source and more info: https://commit2data.nl/en/

Data Innovation Hubs by Commit2Data

Commit2Data and Surf brought together several regional parties in data innovation hubs. Six regional organizations currently work together in these coalition data innovation hubs, having committed to data, data research, and data knowledge sharing. The coalition meets a few times a year to share knowledge on various themes, which include:

- data sharing
- contact between research and industry
- Big Data and SMEs

7. 5G Innovation Network

The 5G Innovation Network aims to encourage the adoption of 5G applications in a wide range of industries by, among other things, identifying promising cases for usage and bringing stakeholders together. When stakeholders are brought together in an industrial context, they can discuss the impact and identify how adoption can be accelerated. In the Netherlands, a growing number of living labs and pilot projects involving 5G technology have been established through public-private partnerships, often aimed at socially and economically valuable applications, which means that 5G can contribute to innovative approaches to:

- Life Sciences & Health
- Agriculture
- Smart cities
- Mobility
- High-tech Systems and Materials

The network partners are:

- telecom companies
- business
- knowledge institutes
- public agencies

The 5G Innovation Network is an initiative of the Ministry of Economic Affairs and Climate and NLdigital.

5G digital experimental gardens and living labs:

A growing number of 5G digital experimental gardens and living labs have been established through public-private partnerships, often aimed at socially and economically valuable applications. The following digital experimental gardens and living labs can be found in Brabant:

- 5G Automotive field lab (Helmond)
- 5G Field Lab, Brainport Industry Campus Eindhoven
- 5G Hub Eindhoven
- mart Connected Supplier Network

8. World Class Maintenance

WCM is the network for "smart maintenance" in the Netherlands, with the objective being 100% predictable maintenance. The network uses smart technologies to contribute to an extended asset lifetime, better mobility, the much needed energy transition, the dissemination of knowledge about the smart technologies, and to the competitive power of the Dutch industry.

WCM believes that smart maintenance is an important step towards a guaranteed quality of life in the future.

The Network performs cross-industrial innovation projects, develops educational programs, and works on an active network in which asset owners, service suppliers, knowledge/research institutions, and public agencies participate. Its association with the FME means that WCM also actively lobbies to prioritize smart maintenance, smart asset management, and smart services on the political agenda.

Focus industries:

WCM's strategy is to have one or more smart maintenance field labs active in every industry where maintenance plays an essential role. These are:

- the infrastructure, from sewerage to rail, from weirs and locks to low-voltage grids
- the processing industry, including the food industry
- the energy industry, including the offshore wind industry
- the manufacturing industry, especially from the perspective of providing smart services for delivered machines
- the built environment, and in particular the utilities, not including housing
- smaller but important industries such as aviation and shipbuilding

WCM focuses on the following subjects:

- Artificial intelligence
- Remote monitoring
- Digital twinning
- Mobile solutions
- Virtual reality/augmented reality
- Internet of Things
- Big Data analytics
- Smart sensors
- Cultural and behavioral changes
- Condition and risk-based maintenance
- Design for maintenance
- Knowledge management
- Interfacing AM IT systems
- Degradation models
- Life cycle costing
- Performance dashboards
- Asset portfolio management
- Performance-based contracting
- 3D Design

Source: https://www.worldclassmaintenance.com/

9. Smart industry

Smart Industry encourages companies to apply smart technology and digitization in order to create new business opportunities. The team was created in November 2014 by the Ministry of Economic Affairs (TNO, Chamber of Commerce, Koninklijke Metaalunie, FME, and the RVO), and has been working on the 2018-2021 Implementation Agenda since the beginning of 2018.

EXAMPLES OF PROJECTS

Throughout the Netherlands, concerted efforts are underway to create a "Smart" industry. Some examples are:

Roadmap 3D printing
Spearheaded by BOM, LIOF, EIZ and the Chamber of Commerce
The digitisation of society has facilitated a new "industrial printing" playing field. Players and application areas range from educational and knowledge institutions, the medical community and the arts and culture sector to small and large companies in the high-tech and automotive sectors. New applications with metal, ceramic or organic materials require a great deal of experimentation, creativity, material, process and equipment knowledge, and perseverance in order to be put into operation. This road map homes in on 3D printing, or Additive Manufacturing Technology.

Product lifecycle management in the value chain
Spearheaded by 85 high-tech suppliers in Brainport Industries
The Brainport Industries cooperative, which comprises 85 1st, 2nd and 3rd tier suppliers, is an initiative working to create a future-proof manufacturing industry. They all share the view that competition occurs more and more between chains rather than between individual companies. One of the projects within Brainport Industries is Product Lifecycle Management (PLM). PLM's goal is to align all life-cycle processes optimally and to thereby optimise the net proceeds of the product throughout its life cycle.

Integrated maintenance and service logistic concepts for maritime asset (maselma)
Spearheaded by Dinalog, industrial companies and knowledge institutions
In the maritime sector, service logistics support and maintenance of systems constitute a significant fraction of the operating costs. It is expected that the project results will enable a significant reduction of the total cost of ownership for asset owners and provide the OEMs/ system integrators and service providers with opportunities for new business. At the same time, from a scientific perspective, the innovative approach to integrating the fields of maintenance, service logistics and supply chain cooperation is expected to have a large impact.

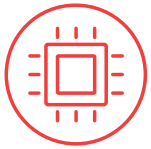
10. ICT Research Platform Netherlands (IPN)

IPN is a platform that brings together IT academics and acts as the authority when it comes to questions regarding the future demands and potential of IT and how to prioritize research in this field.

IPN unites, strengthens, and advocates academic research and education in IT in the Netherlands, helping to fulfil high-quality digitalization agendas that enable society to face the IT challenges of today and tomorrow.

IPN builds and maintains a national community and develops policy to advance the field. The Platform actively enhances diversity in IT by encouraging women and minorities to be a part of it. IPN highlights the importance of IT to our current society.

The Dutch IT field currently has the following five focus areas:



AI and Robotics

Big Data

Blockchain

Cyber security

5G Communicaton

Source and more info: https://ict-research.nl/

11. IT NEXT GENERATION

IT Next Generation is a network of assistant and associate professors exchanging experiences and ideas, defining common interests, working on common roadmaps on IT research, and education in the Netherlands, and jointly influences the national and international IT agenda. The importance of creating these multidisciplinary liaisons is due to the conviction that to keep making an impact, including in the decades to come, the players must know how to find each other and actively work together.

The network was initiated by 4TU.NIRICT and COMMIT, and participants are from VU, UVA, Radboud University, Utrecht University, TU Delft, UTwente and TU Eindhoven, which makes it a very diverse group covering over half of all Dutch universities. IT Next Generation regularly organizes offline and online meetings and get-togethers for its members.

12. NIRICT @ Eindhoven University of Technology

NIRICT is the Netherlands Institute for Research on IT and comprises all IT research conducted by universities of technology in the Netherlands. NIRICT brings together over 70 research groups from the disciplines of computer science, electrical engineering, mathematics, and several IT application domains. More than 1,200 researchers are aboard, which makes NIRICT the most important academic research partner in the Netherlands. Its annual turnover amounts to 77 million euros.

The Strategic Research Agenda themes of the NIRICT are:

- Broadband communication systems
- Computer networks
- Multimedia and VR systems
- Ambient intelligence
- Security
- Enterprise information systems

Vision:

Creating a united 4TU IT community (with 4TU being the four universities of technology in the country) by bringing together research disciplines so that Dutch society and industry can flourish.

Mission:

Strengthening cooperation among 4TU IT researchers and educators via community building.

Source: https://www.4tu.nl/nirict/en/

B. Successful public-private partnerships (PPPs) and networks in brabant

1. AI-hub Brainport (part of the NL AI Coalition)

The AI-hub Brainport encompasses the AI ecosystem around Eindhoven, Helmond, Den Bosch, Tilburg, and Breda. The AI-hub Brainport brings companies, education and knowledge institutes, and public organizations in the province of Brabant together to strengthen and connect activities revolving around artificial intelligence (AI).

The goal is to extend the existing partnerships in the field of AI and the cross-over with (professional) education, societal challenges and joint support for startups, scaleups, and SMEs. The AI-hub Brainport is part of the national AI program developed by the Dutch AI Coalition (NL AIC).

The Brainport ecosystem has a long tradition of open innovation, close collaboration between public and private partners, eminent innovative companies, and a high level of private investment. The international market leaders and suppliers have a strong track-record in product and process creation, development, manufacturing, and market introductions. The unique combination of high-quality technical expertise and the traditional thinking in systems enables Brainport to play an important role in new AI-solutions and applications in the field of high tech, mobility, and MedTech. As a result, the region ranks fourth in Europe in terms of number of AI patents. Alongside the companies, the knowledge and educational institutes have also prioritized AI. It is expected that a large part of the competitive advantage and regional earning capacity will be realized through the application of AI in the near future. Just as important as the economic aspect is the human aspect of AI in the AI-hub Brainport. An important point for attention is, for instance, the social acceptance of AI.

The ambitions of the AI-hub Brainport align with those of the Dutch AI Coalition and the AI-hub Brainport has received kick-start funding from the Netherlands AI Coalition. The formation of the hub means that consortiums are being strengthened while work is ongoing with respect to the AiNed report Versnellen, Vergroten en Verbinden (Accelerate, Enlarge, Connect) and the Action Agenda of the Netherlands AI Coalition.

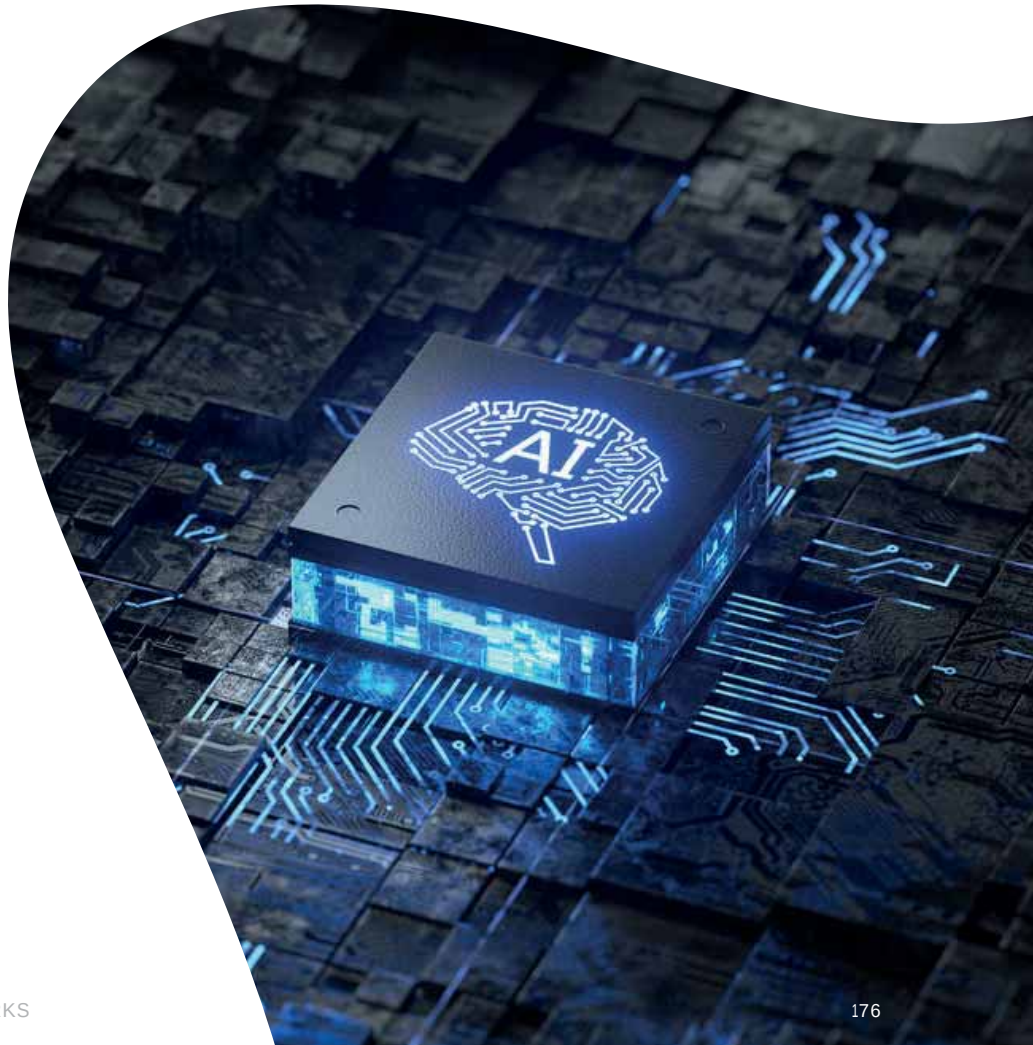
AI FOCUS INDUSTRIES OF THE AI-HUB BRAINPORT:

Industry: Brainport is globally renowned for its unique ability to develop and manufacture products and components of high complexity at a low volume. By integrating AI in systems, Brainport will pave the way for the continuous development of advanced manufacturing technologies.

Mobility: Brainport is leading the world in the field of mobility. AI technology enables the transition to the autonomous, automated, and connected vehicles of tomorrow. The ultimate goal is zero emissions, zero traffic jams, and zero traffic-related deaths.

MedTech: Brainport excels in combining the expertise of clinicians, academics, and engineers and in developing products from the perspective of and together with end-users. Merging AI and medical technology helps to identify faster, diagnose better, and treat smarter.

The AI-hub Brainport is an initiative of BOM, Brainport Development, Brainport Industries, Fontys University of Applied Sciences, High Tech Campus Eindhoven (AI Innovation Center), Jheronimus Academy of Data Science, Tilburg University, TNO, and TU/e (EAISI institute). Industry players, educational and public bodies, and campuses in the form of ASML, the Automotive Campus, Avans University of Applied Sciences, Bosch Security Systems, Breda University of Applied Science, Canon Production Printing, Demcon, High Tech Software Cluster, Mindlabs, NXP Semiconductors, Philips, Prodrive Technologies, the Province of Brabant, Signify, Sioux, Summa College, ThermoFisher, VanderLande, VDL Groep, and others are all partners.



2. High Tech Software Cluster

The High Tech Software Cluster is a partnership of more than 30 innovative software companies, research organizations, and educational institutions that support companies in making digitization affordable and practical.

For many entrepreneurs, digitization – or Industry 4.0 – is a vague term that refers to some very interesting concepts, but is not clearly related to their immediate needs.

The High Tech Software Cluster offers a range of different opportunities to learn about and get started with digital transformation or the engineering of smart products.
Partners in the High Tech Software Cluster include: Alten, Altran, Author E, Ctac, Demcon, Fontys UAS, IBM, IT Group, KPN, Siemens, Sioux, TOPIC, and the Eindhoven University of Technology.

HIGH TECH SOFTWARE CLUSTER

Source and more info:
https://hightechsoftwarecluster.nl/

3. Smart Industry Hub South

The Smart Industry Hub South focuses on businesses in the manufacturing industry in Brabant, Zeeland, and Limburg. Entrepreneurs can obtain information about smart production from a central contact point. The Hub also organizes events and brings entrepreneurs into contact with others who are involved in the same fields. The focus within the Hub is on smart maintenance (smart maintenance and services) and the smart, complex production of small series (smart manufacturing).

The Smart Industry Hub South created the Data Value Center – Smart Industry (DVC-SI) in Eindhoven and Den Bosch. DVC-SI supports entrepreneurs, decision-makers, and professionals when it comes to the optimal use of data – process optimization, developing new services and revenue models, and furthering the required knowledge and competences. Because it is independent and accessible, the DVC-SI can help the Dutch manufacturing industry to respond to the rapidly developing data economy and thus strengthen its competitive position. It makes knowledge, expertise, and cooperative initiatives accessible and bundles them together.

The DVC-SI is a joint initiative of the Brabant Development Agency, Brainport Development, Brainport Industries, FME, JADS, Koninklijke Metaalunie, Midpoint Brabant, REWIN, SURF, and TNO, and is supported by the Province of Brabant and the Ministry of Economic Affairs and Climate.

Source and more info:
https://smartindustry.nl/competence-centers/data-value-center-dvc-si

4. The AI Innovation Center

The AI Innovation Center is an open innovation facility at the High Tech Campus Eindhoven. Its mission is to accelerate the application of data science and artificial intelligence technologies by companies in the larger Brainport Eindhoven area.

The Center is an initiative of the High Tech Campus Eindhoven and was co-founded by Brainport Eindhoven giants Philips, ASML, NXP, and Signify. It aims to drive the adoption of AI by companies of all sizes, improving the regional economy and society. To achieve this mission, the AI Innovation Center brings together technology companies, platform and service providers, research and educational institutes, and other relevant ecosystem partners in a shared facility.

The AI Center focuses on:

- Providing an AI ecosystem and infrastructure
- Accelerating AI projects and applications
- Hosting AI events and education

AI ecosystem and infrastructure

The AI Innovation Center is an open ecosystem for large companies, startups, SMEs, research and educational institutes, and service providers. All activities are focused on stimulating organizations to apply data science and AI technologies.

AI Projects & Applications

The AI Innovation Center, together with its partners, helps companies to get off the ground in applying AI. Whether it is a startup or SME that wants to get more out of its data, or a mature data science and AI technology company looking for the right talent to execute a project, the AI Innovation Center is the place to find the solutions.

The AI Innovation Center is also the place to be for AI application demos to a broad audience. Conveniently located in the heart of the High Tech Campus Eindhoven, on The Strip, the Center has all the amenities to showcase a company's skills. For the most promising startups, the AI Innovation Center offers an incubation period of six months – a soft landing spot. In this period, the startups get (flexible) office space in the Center and access to all relevant knowledge and partners in the ecosystem.

Events and professional education

Knowledge-sharing has been a vital aspect for the open innovation culture at the High Tech Campus Eindhoven. The AI Innovation Center builds on this tradition driving and facilitating knowledge-sharing on AI-related topics. The Center hosts open sessions to get people and organizations onto the learning curve or to keep experienced professionals updated on the latest developments in AI. A professional education portfolio is being prepared with partners.

5. 5G Hub Brainport Eindhoven

The world is changing at an ever-increasing pace. A range of forecasts say that 80% of the worldwide population will live in megacities by 2050, a fact that requires a different approach to topics like sustainability, health, and inclusion.

Consortium

Ericsson, VodafoneZiggo, High Tech Campus, and Brainport Development have formed a powerful consortium, 5G Brainport Eindhoven, with the 5G Hub located at the High Tech Campus as its heart. The consortium researches and tests the potential of new technologies and it stimulates innovative applications thereof. This not only concerns 5G, but also artificial intelligence (AI), virtual reality (VR), augmented reality (AR), blockchain, photonics, and many other spheres.

Ambition

The consortium aims to improve the quality of life and economic appeal of Brainport Eindhoven through new technologies, by working together with the complete ecosystem of startups, established companies, knowledge institutes, public agencies, and political bodies. The consortium is partnered with the Ministry of Economic Affairs in the Brainport National Agenda for Action, which means the solutions devised by the 5G Hub in Brainport Eindhoven can be scaled-up relatively quickly to the rest of the Netherlands. The local network ranges from politicians and administrators to researchers and entrepreneurs. For example, consortium member Brainport Development is the economic development company that stimulates innovation and growth in the region on behalf of the 21 municipalities in southeast Brabant. They are behind the efforts of the 5G Hub. The same applies to the over 200 companies that are a part of the High Tech Campus, from Philips, DAF Trucks, and ASML to promising startups.

5G hub receives two accolades at 2020 computable awards - November 2020

5G Hub is the proud winner of two categories of the 2020 Computable Awards: Hardware & Infrastructure and Digital Innovation. Backed by Computable.nl and assessed by an independent jury, the awards showcase innovative achievements in the IT industry. Seen as "an indispensable link in the introduction of the fifth generation of mobile internet in the Netherlands", 5G Hub's project was highlighted in the Hardware & Infrastructure category. The Connected Ambulance project received the Digital Innovation award, and 5G Hub's partnership with Philips, the GGD Brabant-Zuidoost (the regional healthcare services organization), and the Catharina Hospital exhibits "the possibilities of 5G for healthcare. 5G makes it possible to send more data and to give priority to data traffic by means of network slicing. For example, a reliable connection can be created between a doctor in the hospital and an ambulance team." The 5G Hub team welcomed the news with enthusiasm. Rene Visser, 5G Hub board member for VodafoneZiggo, said that the award "is true recognition of the strong message of 5G Hub." For him, the ecosystem is key: "We need to work together to achieve results. That is the power of co-creation with so many remarkable organizations."

6. ITEA - High Tech Campus

ITEA is the Eureka R&D&I cluster for software innovation, enabling a large international community of major industry, SMEs, start-ups, academia, and customer organizations to collaborate in funded projects that turn innovative ideas into new businesses, jobs, economic growth, and benefits for society. It is industry-driven and covers a wide range of business opportunities facilitated by digitization, such as smart mobility, healthcare, smart cities and energy, manufacturing, engineering, and safety and security.

ITEA converts ideas in important technology fields such as artificial intelligence, big data, simulation, and high-performance computing into concrete business applications.

There are 173 project partners, including ASML, Eindhoven University of Technology, Philips, Siemens, Sioux, Thermo Fisher Scientific, and VDL, all of which are located in Brabant.

Focus areas of ITEA:

Smart cities

Smart communities

Smart health

Smart mobility

Smart industry

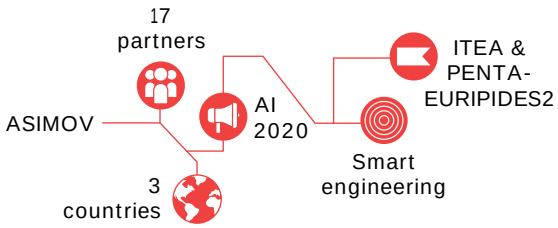
Smart energy

Smart engineering

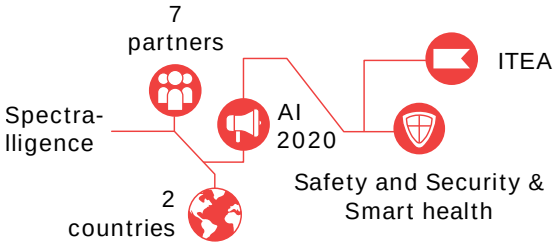
Safety and Security

EXAMPLES OF ONGOING PROJECTS:

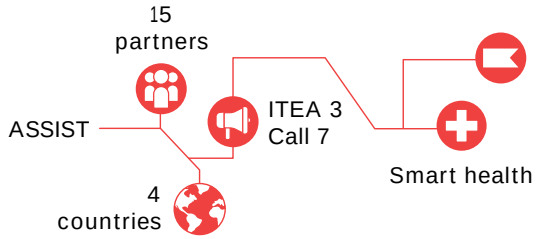
Company logo Fei) ASIMOV - AI training using simulated instruments for machine optimization and verification: With the rise of high-tech cyber-physical systems (CPSs) in all areas of industry and society, the user-friendliness and up-times of these systems has become increasingly important. Keeping the control parameters of CPSs in their correct operating windows is particularly a challenge in, for example, electron microscopy, unmanned utility vehicles, and pulp and paper process control. ASIMOV will increase the autonomy and self-optimization of CPSs by creating physically realistic digital twins of these systems and training innovative AI algorithms for CPS control using these digital twins.



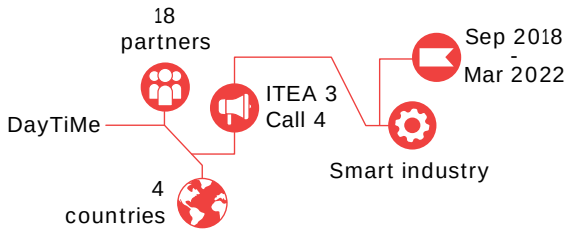
(Company logo Philips) Spectralligence AI - Spectral analysis in life sciences and materials sciences through artificial intelligence: Molecular and atomic spectroscopy is a well-established set of technologies that use the electromagnetic spectrum to generate unique fingerprints of molecular structures, with a broad set of applications in chemistry, medicine, and environmental and safety services. A significant reduction in dependence on human experts is necessary to bring novel technologies to fruition for ever-expanding opportunities. The Spectralligence project aims to demonstrate that cross-domain validated neural networks for spectral analysis, leveraging innovations in micro-electronics and component miniaturization, can significantly accelerate market growth and technology adoption.



(Company logo Philips) ASSIST - Automation, surgery support and intuitive 3D visualization to optimize workflow in IGT systems: Current software image-guided therapy applications to assist physicians still require significant manual user interaction while all attention should be on the patient instead. The ASSIST project will develop technologies and solutions to get the physician back in control of the clinical procedure by assisting or automating part of the physician's tasks during image-guided therapy procedures. The aim of the project is to optimize and simplify the workflow in image-guided therapy procedures with the main goal of streamlining physicians' work, optimizing imaging systems, improving patient outcomes, reducing human error, and reducing costs.



(Company logo Philips) DayTiMe: The DayTiMe project will extend the Industry 4.0 concept and apply it beyond the manufacturing line environment, for which it was devised, into the healthcare and lifestyle industries. DayTiMe will develop an overall architecture based on digital twins, which means that in addition to each physical object a virtual model will exist enriched with data related to a specific instance of the physical version. DayTiMe will validate its innovations in three non-manufacturing use cases and one industrial manufacturing use case.



7. ARTEMIS Industry Association @ High Tech Campus

ARTEMIS Industry Association is the association for actors in embedded intelligent systems within Europe. As a private partner, the association represents its members - industry, SMEs, universities and research institutes - in ECSEL Joint Undertaking. ARTEMIS Industry Association continuously promotes the R&I interests of its members to the European Commission and the public bodies of the participating states. The association strongly believes that the continued success of the embedded intelligent systems industry in Europe depends on a single coordinated, pan-European strategy. Forming this strategy is a part of the ARTEMIS European Technology Platform, which is developed and executed by the ARTEMIS Industry Association.

Members of ARTEMIS include Philips, TNO, Neways Technologies, Enexis, Atlas Technologies, NXP, and the Eindhoven University of Technology.

ARTEMIS
Industry Association

SOME BRABANT PROJECT LEADER PROJECTS:

FITOPTIVIS: Images play a central role in human perception and understanding of our environment. In the same manner, cyber-physical systems need visual context and awareness to make autonomous and correct decisions, and to take appropriate actions. However, advanced image and video processing is computationally intensive and challenging. The objective of FitOptiVis is to develop a cross-domain approach covering a reference architecture, supported by low-power, high-performance smart devices, and by methods and tools for combined design-time and run-time multi-objective optimization within the constraints of the system and environment. Low latency image processing is often crucial for autonomy and the correct interaction of the CPS with its environment.

Moore4Medical: The Moore4Medical project addresses emerging medical applications and technologies that offer significant new opportunities for patients as well as for industry including – bioelectronic medicines, organ-on-chip, drug adherence monitoring, smart ultrasound, radiation free interventions, and continuous monitoring. The new technologies will help to fight the increasing cost of healthcare by reducing the need for hospitalization, help to develop personalized therapies, and create intelligent point-of-care diagnostic tools.

ASTONISH: The project will deliver breakthrough imaging and sensing technologies for monitoring, diagnosis, and treatment applications by developing smart optical imaging technology that extends the use of minimally invasive diagnosis and treatment and allows for unobtrusive health monitoring. The project will integrate miniaturized optical components, data processing units, and SW applications into smart imaging systems that are less obtrusive, cheaper, more reliable, and easier to use than state-of-the-art systems. The end-result will be six demonstrations that will validate the technologies and allow for pre-clinical testing within the scope of the project.

8. Innovation Center for Artificial Intelligence in Brabant

The mission of the National Innovation Center for Artificial Intelligence (ICAI) is to ensure the Netherlands stays at the forefront of knowledge and talent development in AI. Creating and nurturing a national AI knowledge and talent ecosystem is the central aim of the organization.

ICAI's innovation strategy revolves around network-labs – multi-year strategic collaborations with a focus on technology and talent development. In the labs, ICAI's partners create innovative AI applications, attract and develop talent, and distribute AI knowledge for companies and organizations in the form of technology products and tools, train corporate employees through dedicated courses, and simultaneously maintain a connection with other world-level science centers. ICAI is an open national network of academic, industrial, and public partners.

ICAI LABS ARE LOCATED IN THREE LOCATIONS IN BRABANT:

Eindhoven

The **AI-enabled Manufacturing and Maintenance (AIMM)** Lab is a joint venture between Eindhoven University of Technology (TU/e), KMWE, Lely, Marel, and Nexperia. The lab's goal is to develop better data science techniques that result in improvements in both manufacturing and maintenance processes. The AIMM Lab was established by the Eindhoven Artificial Intelligence Systems Institute (EAISI) to promote AI research in cooperation with industry. The areas of research of the AIMM Lab will directly interface with topics such as autonomous agents and robotics, computer vision, decision making, information retrieval, knowledge representation and reasoning, neuro-linguistic programming, and machine learning. Within the lab, industry partners and the TU/e will jointly develop research proposals with companies in the region.

The **FAST LAB** (new Frontiers in Autonomous Systems Technologies) is a joint venture between Eindhoven University of Technology (TU/e), Lely, Rademaker, Diversey, ExRobotics, and Vanderlande. The industrial partners share a common R&D requirement in that they want their mobile robot systems to operate safely and performantly in environments that are subject to static and dynamic changes. Tasks, environments, and variations that we know in advance will arise but not the order or configuration in which they will arise – a more scalable, non-conservative, and explainable solution is required to explicitly cope with these changes. The lab comprises expertise from different fields of expertise that examine system-engineered solutions to cope with the complex challenge at hand. The lab's team of experts are drawn from the fields of human technology interaction (HTI), software system design (SSD), perception systems (PS) and control systems technology (CST).

The **e/MTIC AI Lab** is a partnership between Eindhoven University of Technology, Catharina Hospital, Maxima Medical Center, Kempenhaeghe Epilepsy and Sleep Center, and Philips. The main aim of e/MTIC is to fast-track high-tech health innovations. The e/MTIC AI Lab focuses on improving personalized treatment by having clinical staff and MedTech industries work closely with AI, given that it is better able to make reliable decisions in a wide range of healthcare situations. It will play a role in decision-making and continuously learn to be a better partner. This requires new approaches, new models, and new benchmarks for the reliability, efficacy, and trust-worthiness of AI. The goal of the e/MTIC ICAI Lab is to work with a unique mixture of industry, clinical partners, and TU/e researchers to maximize the value of AI in clinical practice.

EAISI Mobility Lab is a partnership between Eindhoven University of Technology and NXP Semiconductors. It aims to use the ongoing digitization of vehicles and transport services to ensure accident-free mobility. At present, too many people die or get hurt on our roads. The researchers at the Mobility Lab believe that technology, and AI in particular, can make vehicles inherently safe by giving drivers real-time support in critical situations. In order to achieve this goal, the team uses technologies such as machine learning, world modelling, optimized human-machine cooperation, new vision and radar systems, and ultrafast actuators. The Mobility Lab aims to design intelligent mobility systems that sense their environment, learn and understand it, and, in interacting with humans, reason about which action to take to achieve specific goals. Examples include new types of cruise control systems, pro-actively adjusting speed based on surrounding vehicles, traffic jam assistance, and platooning.

Den Bosch

KPN Responsible AI Lab is a joint venture between KPN and the Jheronimus Academy of Data Science (JADS). The lab will focus on developing technologies that allow artificial intelligence to be used in a responsible way by developing transparent, privacy-aware, and personalized AI solutions for businesses.

Tilburg

MasterMinds Lab is a partnership between Tilburg University, Fontys Hogescholen, ROC Tilburg, Actemium, CastLab, Interpolis, Marel, Multisim, the Municipality of Tilburg, the Port of Rotterdam, the Royal Netherlands Airforce, SpaceBuzz, TimeAware, and WPG Zwijsen. The Lab aims to develop interactive AI technologies such as serious gaming, augmented and virtual reality, intelligent tutoring systems and natural language processing, and data science. The goal of the MasterMinds Lab is to develop AI technologies combined with its impact on and input from human behavior, across multiple industries in the fields of aerospace, logistics, maintenance, and education, with the focus on robotics and avatars, serious gaming and learning, language and data science technologies, and virtual and augmented reality solutions.

9. Breda Game City

Breda Game City is a brand-new network organization that focuses on elevating the Breda video games industry and creating a professional, healthy, and creative environment. The most important goals of Breda Game City are supporting Breda videogame professionals in their careers and providing information to international companies on why Breda is the perfect city to establish a business in.

The partners of the network are:

- Breda Municipality
- Breda University of Applied Sciences
- Vanlersel Luchtman Advocaten
- Studio SAYO KATO

10. Platform Driven by Data – Doing business with data

Platform Driven by Data is a public-private partnership to help SME entrepreneurs engage in digitization and datafication. This first data workshop in the Netherlands was set up on the initiative of Rabobank's Den Bosch and surroundings branch, VNO-NCW Brabant-Zeeland, Bossche Investerings Maatschappij (BIM, the Bossche investment agency), and Jheronimus Academy of Data Science (JADS), which is a partnership between Tilburg University and Eindhoven University of Technology. The platform is supported by the Ministry of Economic Affairs and Climate (EZK), the province of Brabant, and the municipality of Den Bosch. The network has now been expanded to include the Avans Digital Workshop and the network of supporting expert companies continues to grow.

Since 2018, almost 200 entrepreneurs have been assisted. Platform Driven by Data has been a foundation since the end of 2019 and its board consists of Rabobank Den Bosch and surroundings branch, VNO-NCW Brabant-Zeeland, and the Bossche Investerings Maatschappij.

Source and more info: Platform Driven by Data – Ondernemen met data

Data Science for Logistics Innovation (DALI)

Under the name DALI (Data Science for Logistics Innovation), concrete applications of data science in the supply chain are created on the basis of business cases. DALI is a testing ground for raising data certification in the logistics industry in the southern Netherlands to a higher level and thus making the industry future-proof. DALI focuses on the development of knowledge-intensive logistics (smart logistics) – devising, developing, demonstrating, and applying new logistics methods, all with the aim of creating greater value, the more efficient handling of goods flows, and retaining our international market position.

To achieve this, DALI has developed a number of testing grounds where data is implemented in actual business cases. DALI is a co-project of the European Union, OPZuid, the Province of Brabant, REWIN, Midpoint Brabant, Breda University of Applied Science, Regio West-Brabant, Regio Hart van Brabant, the Ministry of Economic Affairs and Climate, and the cities of Tilburg and Breda.

Source and more info: https://dali.lcb.nu/

8. GOVERNMENT SUPPORT

A. Government support structure

On a national level, the Dutch national and regional authorities work together through the Invest in Holland consortium to help foreign companies establish themselves in the Netherlands. The national investment agencies NFIA (the Netherlands Foreign Investment Agency), HIDC (the Holland International Distribution Council), and all Dutch provinces, regions, and metropolitan areas work together under the Invest in Holland brand.

In the province of Brabant, a broad support structure has been developed by regional and local governments for Life Sciences & Health companies. The provincial government and the municipal authorities of all the larger Brabant cities generally have a positive, practical, and supportive attitude towards the industry and want to see it prosper in the region. Teams of professionals exist in many organizations for providing operational and strategic support to LS&H, including BOM, Brainport Development, REWIN, team Pivot Park, team High Tech Campus Eindhoven, team TU/e, and many others.

Five operational government agencies in Brabant have been specifically established to support industry:

- **BOM - Brabant Development Agency**
- **Brainport Development Eindhoven**
- **REWIN West Brabant**
- **AgriFood Capital**
- **Midpoint Brabant**

1. Invest in Holland / NFIA

Under the name Invest in Holland (IiH), the Netherlands Foreign Investment Agency (NFIA), the operational branch of the Ministry of Economic Affairs, has joined forces with the Ministry of Foreign Affairs and several regional partners in the Netherlands. The network represents and showcases the Netherlands in other countries as an attractive location to invest in or to establish a business. It supports interested foreign companies in setting up or expanding their international activities in the Netherlands.

SERVICES

- The NFIA provides information, practical assistance and advice to foreign companies
- It was founded 40 years ago as an operational unit of the Dutch Ministry of Economic Affairs
- It is responsible for identifying and attracting direct investments (green field or expansion) from companies that could be made in various countries, including the Netherlands
- It provides access to a broad network of business partners and government agencies
- It is headquartered in The Hague and has a staff of 35
- NFIA initial support is provided abroad through its 27 offices and representatives around the world, staffed by around 75 people
- The NFIA works closely with embassies, consulates and other organisations that represent the Dutch government around the world, as well as with a broad network of partners in the Netherlands

Source and more info: https://investinholland.com/

2. BOM -
The Brabant Development Agency

SERVICES

When companies are in the process of relocating, setting-up a new subsidiary or expanding their operations, they need the essentials to be taken care of quickly and comprehensively. BOM Foreign Investments was established to be the industry's partner for every one of those steps, providing a wide range of services and support that save on both time and money. BOM has a local team of experts available that provide free support for a wide range of matters – whether it be issues with building permits, finding new premises or sites for development, questions on employment law, understanding tax incentives, or help with business development and networking, and creating consortiums for joint research and innovation.

Based in Tilburg, BOM Foreign Investments is part of the Brabant Development Agency (BOM), which is staffed by 85 highly specialized professionals. In order to facilitate foreign investment in Brabant, the team combines its services with the unique expertise and support of their colleagues working in complementary fields within BOM, expertise that includes managing R&D programs, initiating innovative industrial cooperative projects and venture capital funding.

1. Support for foreign companies – the strength of Brabant; a world-class economy
Located centrally in one of the world's largest markets and with a supply industry and a world-class knowledge economy, Brabant is an attractive location for many foreign companies. BOM Foreign Investments highlights the strengths that Brabant offers and assists newcomers and established foreign companies alike to fully utilize the province's opportunities as a business location.

BOM always works closely with the Netherlands Foreign Investment Agency (NFIA) and the Holland International Distribution Council (NDL), the country's logistics agency, in order to provide potential investors with the following essentials:

- Information: national and regional regulations are demystified by BOM's team of experts, and they provide information on taxes and the business climate in the investor's industry.
- Network: a business and supply-chain network and talent acquisition are key to a company's success and often prove to make all the difference. BOM and partners introduce newcomers to Brabant (or companies looking to expand) to their extensive network of contacts in industry, academia, and government, ensuring that investors immediately have the best possible contacts.
- Location and site selection: where and when – both crucial decisions in the investment process. BOM can function as a potential investor's guide and advisor from start to finish and help look for suitable sites until a perfect fit has been found.

2. Doing business abroad
BOM International Trade offers those businesses that have outgrown their Dutch roots hands-on support for growing successfully in foreign markets. BOM establishes relevant business and government contacts abroad and provides targeted information on markets and available funding. The International Trade team focuses on three of Brabant's priority industries: High Tech Systems & Materials, Life Sciences & Health, and AgriFood.

BOM is a public agency that brings companies, knowledge institutes, and public agencies together. As BOM has no commercial interests, its independent standing opens doors that often remain closed to commercial ventures. In this respect, BOM's goal is to help to create a strong Brabant economy and guarantee that Brabant businesses play a leading role on the world stage. Current target markets for BOM International Trade include China (Jiangsu region), southern Germany (Baden-Württemberg and Bavaria regions), and the United States (Midwest and Texas). BOM International Trade works closely with partners such as the Netherlands Enterprise Agency, the Chamber of Commerce, and embassies and consulates around the globe.

3. Doing business in Brabant - expertise and risk capital for startups and scaleups
As a growth accelerator with over 35 years of experience, BOM Brabant Ventures helps ambitious Brabant companies to grow in a future-proof manner. Through its knowledge, experience and venture capital, the Brabant Ventures focuses on startups and scaleups in Brabant's Priority Industries: High Tech Systems & Materials, AgriFood, the Biobased Economy, Life Sciences & MedTech, and Maintenance & Supply Chain.

4. Helping industrial clusters and business ecosystems in Brabant grow
BOM Ecosystems Development assists in bringing the right companies and institutions and the right people together to accelerate innovation and generate new business for your company. This could entail the expansion of an existing business, moving in a new strategic direction, integrating sustainability in your core activities, and/or developing a new business model. Partnerships can be formed in Brabant or across the Netherlands as well as on an international scale, working together with BOM Foreign Investments & Trade.

Because innovation requires time, effort, knowledge, facilities, and financial resources, BOM Ecosystem Development believes that small and medium sized enterprises (SMEs) can accelerate the market launch of innovative products by working together. Partnerships can be forged with other SMEs and/or large companies and by joining forces with knowledge institutes and public agencies. The BOM team will help your company find these partners and set up the cooperative venture.

5. Creating energy projects - contributing to energy transition in Brabant
BOM Renewable Energy facilitates energy conservation and sustainable energy generation. The team works with businesses, property owners, and citizens' initiatives to create sustainable energy projects. BOM Renewable Energy encourages energy conservation in the property market and industry and provides advice and assistance for cost-effective solutions that will help make Brabant energy-neutral.

BOM Renewable Energy advises on project organization and structuring and can also invest in these projects and use its network to kick-start projects. The team's focus is on major projects, such as wind farms and solar parks, and on connecting and bringing smaller projects together. Smaller projects are supported through BOM's ESCO (energy service company) partners, who are active in specific markets, such as solar panel manufacturing or social housing and energy conservation for SMEs.

Source and more info: https://brabantisbright.nl/ and bom.nl

3. Brainport Development Eindhoven

SERVICES

As part of Brainport Eindhoven, Brainport Development helps with innovation and economic development. Brainport Development is helping the region to grow economically by attracting international high-tech and manufacturing companies and by providing them with local support. From startups and scaleups to large multinationals, Brainport is sharing knowledge, providing advice on issues such as funding, and putting them in touch with other companies and (international) talent. It is also responsible for creating the economic strategy defined by the Brainport Foundation. In order to deliver that strategy, Brainport Development works together with companies, knowledge institutes, and public agencies as an independent party.

The region's philosophy is "we can grow faster when we grow together" and that businesses only require occasional guidance or additional assistance. And this is what Brainport Development offers to both foreign and local companies. In reality, it is an economic development association and is funded by all 21 municipalities within the Brainport region.

Brainport Development

Source and more info: https://brainporteindhoven.com/en/

4. REWIN West-Brabant

REWIN West-Brabant, the regional development agency for the western region of Brabant province, works to boost the regional economy by encouraging business investment. REWIN provides support for establishing and/or relocating both branch offices and entire companies, and it has a special interest in the following key industries: logistics, maintenance, AgriFood/ biobased economy, and creative services.

SERVICES

REWIN provides help and guidance on a wide range of topics, including:

- Advice on availability and the pricing of business locations in the western part of Brabant, including advice on locations and viewing properties together with you
- Support for legal and tax issues, such as incorporating a business or appealing a tax assessment
- Information on the regional business climate, labor market and residence and work permits
- Guidance on the availability of financial assistance, grants, venture capital and private investment opportunities
- Assistance with grant and permit applications
- Information on staff recruitment and training, current labor, and salary conditions

REWIN will assist newcomers to western Brabant through introductions to its network of local authorities, educational institutions, knowledge networks, technological expertise, and business networks throughout the region. Companies can also participate in a range of business development programs in the key economic industries of logistics, maintenance, and the biobased economy.

Source and more info: www.rewin.nl/en

5. Midpoint Brabant

Midpoint Brabant is the economic cooperation program for the central Brabant (Tilburg) region. Midpoint Brabant acts as a link between industry and business, government, education and science, and social organizations. The program helps to develop new ideas and bring these ideas to the market, with the objective being to stimulate innovation that makes the economy "smart and strong" and contribute to a future-proof society.

Spearheads of the regional economic development program are:

- Smart industry
- Smart logistics
- Smart leisure
- Smart services

In central Brabant, these industries flourish in a smart society surrounded by a great landscape. The region is already a strong international player in this area and is aiming for further growth. Midpoint does this by actively responding to attractive developments and promoting cross-links between industries. In its program it emphasizes projects that are innovative to the industry, contribute to a circular economy, and have increased employment. Putting knowledge into practice, smart bundling knowledge and skills, is what the region is known for.

Central Brabant has a strong knowledge and education structure, with three senior secondary vocational institutes, two colleges, a leading university, and many associated knowledge institutes. Midpoint Brabant links these institutions to the business world, from concept through to successful implementation. The combination of vocational training with on-the-job experience also ensures that innovations will be applicable in practice.

Midpoint prefers to develop projects within field labs (testing grounds), in which ideas are tested and put into practice. These living lab projects are aided in a well-functioning ecosystem, in which "houses" and campuses that are set up play an important role. Midpoint brings together partners with the right social and technological knowledge and skills and supports them in finding talent, financing, and contributing to SME startups and growth.

Source and more info: www.midpointbrabant.nl/introductie/over-midpoint-brabant/

6. Holland Expat Center South

Holland Expat Center South is a non-profit governmental agency that is a joint initiative of the participating municipalities (almost every municipality in Brabant), the Netherlands' Immigration and Naturalization Services (IND), Brainport Development, and the province of Brabant.

SERVICES

The Holland Expat Center South compiles the procedures and provides information that helps expats and their families to settle into their new living (and working) environment. Expats can obtain information about the region from the Expat Center and learn more about events organized specifically for the expat community. Its main purpose is to help expats feel welcome and at home.

The Expat Center helps companies employing expats and expats themselves to fulfil the formalities required for residing in the Netherlands, such as acquiring the compulsory BSN (Citizen Service Number), help with visa/residence permits, work permits (if required), converting a driver's license, TB testing, etc.

holland
expat center
south

Source and more info: www.hollandexpatcenter.com/

B. Incentives and Grants/Support Programs

1. Highly-skilled Migrant Permit

Highly-skilled migrants do not require an employment permit to work in the Netherlands. The national scheme for highly-skilled migrants is available for employee transfers that do not fall under the scope of the EU's intra-corporate transfers (ICT) directive. This may be the case for employees who, for the duration of their assignment, are placed on the Dutch payroll of the recipient company. Japanese nationals and Turkish nationals do not require an ICT residence permit either; they can apply for a highly-skilled migrant residence permit.

What is a highly-skilled migrant?

A highly-skilled migrant or knowledge migrant (in Dutch, a kenniswerker) is any foreign employee who:

- comes to the Netherlands to work as an employee
- earns at least €4,612.00 (excluding holiday allowances and 13th cheque) gross per month
- or earns at least €3,381.00 (excluding holiday allowances and 13th cheque) gross per month, if under the age of 30

These salary amounts are applicable for 2020. The sums are index-linked annually.

Fixed allowances for housing and a company car may be added to the employee's base salary in order to comply with the above salary criteria, but only if these allowances are agreed to in writing and paid in monthly instalments.

An application for a permit can be declined if the salary is not a competitive one in the industry in question. This income requirement does not apply to scientific researchers and physicians training to become specialists, or to people working for educational or research institutions.

Employers that wish to employ highly-skilled migrants are no longer required to also apply for work permits for these employees, and they now only have to submit an application for admission and residence for the employee and his family to the Immigration and Naturalization Department (IND). The application procedure takes around two to three weeks. A residence permit for highly-skilled migrants will be granted for the duration of the intended employment, up to a maximum of five years.

Professional soccer players and ministers or teachers of religion are not eligible for residency as highly-skilled migrants. Directors and major shareholders cannot apply for the knowledge migrant scheme either if they hold a stake greater than 24% in the company, as they are then liable for any company risks and can influence their own incomes.

The income requirement for highly-skilled migrants will be reviewed on 1 January of every year on the basis of the most recent index figure for negotiated salaries, as published by Statistics Netherlands (CBS). The average yearly increase of the salary criteria has been 2.6% for the past three years. Whenever a highly-skilled migrant submits an application for the extension of his or her residence permit or switches employers, the IND will apply the most recently indexed salary criteria. Thus, if a highly- skilled migrant applies to extend his or her residence permit three years after being admitted for the first time, he or she must take into account that the applicable salary criteria has increased by almost eight percent.

If a highly-skilled migrant under the age of 30 continues working for the same employer after turning 30, the lower salary requirement that was in force when he or she first applied for a permit remains applicable. If the highly-skilled migrant applies for an extension and continues to work for the same employer, the most recently indexed salary criteria for the under-30 age category is applicable. However, if this employee switches employers after turning 30, the most recently indexed salary for those over the age of 30 is applicable.

2. The 30% ruling (tax-free allowance)

The Netherlands has a special tax regime for expatriates, known as the 30% ruling, which exempts them from a substantial portion of their income tax (up to 30%). This is viewed as a reimbursement of the extra costs involved in living abroad, the extraterritorial expenses. Rather than having to specify and prove the extraterritorial expenses incurred by an employee or an employer for its employees each year, the costs are set at a maximum of 30% of the taxable remuneration. In addition, the employer may reimburse certain costs tax-free. This includes international school fees, certain relocation expenses, and a moving allowance up to a given limit.

The part of the income to which the allowance applies

Under the tax rules, the employer may grant the employee a tax-free allowance of up to a maximum of 30% of his or her taxable remuneration package. Incidental and flexible forms of income such as bonus payments and stock options that are paid out during the duration of the 30% ruling are also included. Severance and pension payments, however, are excluded.

Method of calculation

Under the regulation, the taxable and the non-taxable part of the income must be split in the employment contract itself. In other words, the 30% tax-free allowance must be granted as a separate part of the employee's salary. Standard wording is used to state this in either the employment contract or in a separate addendum to the contract. For employees with net salary contracts and irregular payments, it can be difficult to precisely determine the non-taxable part of 30% on a monthly basis, and so in these cases they may determine and pay the exact tax-free reimbursement on an annual basis.

Ruling and pension

An employee cannot accrue a pension under a qualifying plan in the Netherlands (or social security benefits) on the tax-free allowance. This affects employees who have a pensionable base equal to their full gross salary. Employees who may apply the 30% ruling may only accrue pension on the taxable part of their salary. There is way to avoid this, although the employer must fulfil a number of legal formalities and draft special documents for this purpose.

Extraterritorial costs

The 30% ruling is a practical solution for employers wishing to reimburse, tax-free, the additional costs incurred by the employee working in the Netherlands as opposed to their home country, the extraterritorial costs (instead of keeping all receipts of the actual costs claimed by the employee). The Dutch State Secretary passed a special decree that further detailed which costs, allowances, and benefits in kind that are typically paid to expatriates qualify as extraterritorial costs. In the case an employee who was hired or assigned from abroad to work in the Netherlands and was not deemed eligible for the 30% ruling, it is still possible to reimburse the de facto extraterritorial costs to this employee tax-free. In this event, the employer must retain proof of the extraterritorial expenses incurred.

International school fees

Under the 30% ruling, the employee may receive an additional tax-free reimbursement of the fees paid for children to attend an international school. A school is regarded as an international school when a) the education is based on a foreign school system, and b) in principle the school only accepts the children of foreign employees.

Relocation expenses/moving allowance

The costs of moving as well as the costs for transporting household goods as part of the employment or secondment package are not considered extraterritorial costs, which means that these costs can - to a certain extent - be reimbursed tax-free. Actual relocation costs of up to ¤7,750 (2019) can be reimbursed.

Period of validity of the 30% tax-free allowance

The 30% ruling is available for a period of five years (60 months). The rules stipulate that the tax authorities can demand that the employer demonstrates at all times that the employee still meets the conditions. Where the employee no longer meets the conditions of the 30% ruling, it can no longer be applied. This will result in a retroactive adjustment (when required). If the employee's contract in the Netherlands has ended, the 30% ruling will also simultaneously cease to apply. As such, the 30% ruling cannot be applied to any payments made after that time.

The duration of any previous stay or period of employment in the Netherlands is subtracted from the maximum five-year period. However, this reduction will not occur if the expatriate has not stayed or worked in the Netherlands during the 25 years preceding his or her most recent arrival date in the Netherlands (or has only done so for very brief periods).

Conditions for qualifying

In order to qualify for the 30% ruling, the following conditions must be met:

- The employee (board members and supervisory board members also qualify for the 30% ruling) must be recruited (or assigned) from abroad;
- The employer must be a Dutch wage tax-withholding agent. If the employee has a Dutch resident employer (a Dutch corporation or branch of a foreign corporation) this condition is usually met. If the employee has a foreign based employer which has no taxable presence in the Netherlands, the employer must have one or more employees working in the Netherlands, perform payroll administration in the Netherlands, and be registered as a withholding tax agent with the tax authorities.
- The employee must have lived outside of a 150 km radius from the Dutch borders for at least two-thirds of the 24 months prior to the start of their employment in the Netherlands;
- The employee must have the specific expertise required to perform the function and which is not available or scarce on the Dutch labour market. This is based upon a salary standard that must be met; and
- The 30% ruling must be contractually agreed upon between the employer and employee. This also implies that the employee is aware that the 30% ruling reduces his or her gross salary.

3. Incentives for Research and Development Costs in the Netherlands (WBSO)

Companies established in the Netherlands performing research and development work (Speur- en Ontwikkelingswerk: S&O or R&D) may be eligible for tax relief on wage costs and additional costs. The WBSO R&D scheme is intended to provide entrepreneurs with an incentive to invest in research by means of reducing the R&D wage costs. The WBSO scheme for R&D includes salary and other costs and expenses directly related to R&D activities.

The benefit amounts to 32% of the first ¤350,000 of R&D costs (both salary and other costs and expenses) and 16% for R&D expenses above ¤350,000. For startups, the percentage for the first bracket is higher, at 40% instead of 32%. The WBSO does not have an upper limit, although the maximum benefit may not exceed the wage sum.

Contribution

The R&D allowance takes the form of a reduction in wage taxes and social security contributions. The WBSO can be applied to costs and expenditure directly allocable to the company's R&D activities, whereby:

1) costs must be incurred exclusively (for 100%) for R&D;
2) expenditure must serve R&D (can also be partly allocable).

When applying for the WBSO one can choose between a lump-sum application (based on the number of R&D hours; no R&D expenditure will be subsidised) or an estimate of the actual amount of costs and expenditure incurred.

Actual costs and expenditures

Only costs and expenditure directly allocable to R&D and which serve R&D purposes can be taken into account. In this respect, note that not all activities related to R&D projects can be recognised as R&D work. For example, administrative and organisational costs are excluded.

As far as the costs are concerned, it is only those costs that are borne by the taxpaying company itself). When it comes to expenditure, the allowance only applies to newly manufactured business assets insofar as:

- these assets have not been previously used;
- they have not been included in previous R&D declarations (subsidy applications);
- these assets fall under own R&D activities;
- expenses are borne by the taxpaying company payer (or a group company of an affiliation, in tax terms, that the taxpaying company is a part of)

Conditions

The R&D project must meet the following conditions before one can apply for the R&D allowance:

- the proposed R&D activities take place within your own company
- the technological development is new to your company
- the development brings with it technical issues
- the R&D work has yet to be undertaken (which means you must always submit a WBSO application in advance).

R&D work is defined as a systematically organised activity, related directly and exclusively to:

- technical scientific research
- the development of:
  - (Parts of) physical products
  - (Parts of) physical production processes
  - Software (technically new (parts of) software)
  - Software components (technically new)

WBSO support is explicitly NOT intended to support feasibility studies, software upgrading, software modifications for different hardware or software platforms, developing services, routine activities, market research, organizational or administrative work, policy and strategy studies, the adaptation or deployment of purchased goods, quality control and assurance, the adaptation or implementation of existing technology, pilot plants, and related products on a production scale with commercial value.

4. Innovation Box

Companies can benefit from an effective tax rate of just 7% for income from intangible assets created by their Dutch taxpaying entity. The effective tax rate of 7% will increase to 9% in 2021. Patented intangible assets as well as intangible assets that have been created by the Dutch taxpaying entity and for which an R&D declaration (an approved WBSO application) was obtained, may qualify for the Innovation Box. In practice, this means that technological innovations developed in-house qualify.

The reduced tax rate of 7% is claimed in the corporate income tax return filed by the Dutch taxpaying company. In reality, this tax rate qualifies as an exemption for a substantial part (72%) of the profits that can be allocated to the Innovation Box. By applying the general Dutch corporate income tax rate of 25%, this gives an effective rate of approximately 7%.

The Innovation Box does apply:

- in situations where the period between an application for a patent and the granting of the patent is unusually long. Subject to certain conditions, profits that are attributable to the relevant patented asset may, during the period from the year in which the patent was applied for up to the year preceding the year in which the patent was granted, also be brought within the scope of the Innovation Box.

The Innovation Box does not apply:

- to marketing intangibles such as trademarks and logos
- to intangible assets for which a patent was obtained if the asset was already in existence before 1 January 2007
- to intangible assets for which an WBSO R&D declaration was obtained if the asset was already in existence before 1 January 2008

As a result of EU talks on favorable EU IP regimes and the introduction of minimum rules for preferential IP regimes (OECD BEPS project), as of 2017 the Netherlands has altered the Innovation Box regime in order to be compliant with the new requirements. The changes relate to the entry tickets to the Innovation Box (you now require a WBSO R&D declaration) and allocation of income that qualifies for the special tax rate.

Originally, there was no cap on the amount of profits that could be allocated to the Innovation Box, although a taxpayer had to be able to prove that the profit was related to the qualifying intangible assets. As of 2017, restrictions have been introduced (the modified nexus approach). It is recommended that an agreement be reached in advance with the Dutch tax authorities on which method to apply – they will do this on request. At present, the Innovation Box regime has the following relevant features:

R&D Activities (entry ticket)

Originally, the Patent Box regime could only be applied to income generated from registered patents, but this has now been extended to include income from R&D projects for which a WBSO R&D declaration has been obtained. Henceforth, a distinction is drawn between small and other taxpaying companies.

Small taxpayers are companies with worldwide net group sales of under ¤50 million per year and a gross benefit from IP not exceeding a total of ¤37.5 million in five consecutive years (an average of ¤7.5 million per year). For small taxpaying companies the WBSO R&D declaration suffices as an entry ticket to the Innovation Box.

Larger taxpaying companies not only need to obtain a WBSO R&D declaration but must also have a recognized legal access ticket. For larger taxpaying companies, only income from patents, utility models, software, plant breeders' rights, and pharmaceutical certifications qualify for the Innovation Box regime. This category of taxpayers will thus be subject to a twofold test. A small taxpaying company can also include unprotected IP in the Innovation Box regime.

Maximum revenues (allocation of income)

A restriction is in place with respect to the level of income that can be allocated to the Innovation Box (the modified nexus approach). It is now more important whether or not R&D will be performed in-house and how R&D costs are divided between the parties involved. This implies that the more R&D activities are outsourced to related parties, the lower the profits that can be allocated to the intangibles resulting from such R&D activities.

5. Innovation credit

The Netherlands Enterprise Agency (RVO) can assist companies with promising but high-risk projects that banks and other investors decline to invest in. This facility is available for companies with an innovative concept, that see opportunities for a new product in the market, and that have the knowledge, the vision, and the ambition, but lack the financial clout. The Netherlands Enterprise Agency can grant these companies a direct loan that enables them to finance a part of the project costs. This loan is known as an Innovation Credit. All companies, whether startups or an established one, can apply for the Innovation Credit. Innovation Credit will help companies become more innovative and help the Dutch economy to become more sustainable.

When applying to the Innovation Credit scheme several conditions must be met. The RVO recommends that a quick scan be performed before applying.

Source and more info: https://english.rvo.nl/subsidies-programmes/innovation-credit

9. TRENDS AND DEVELOPMENTS – THE BIGGER PICTURE

The year 2020 was truly a historic one. The Covid-19 pandemic dominated headlines and the lives of all people worldwide in ways that would have been unimaginable a year before. The biggest health and economic crisis in recent history forced companies across industries to adopt extraordinary measures to protect their staff and continue operating. The outbreak has impacted and still is impacting all industries, including the information and communication technology (IT) industry.

Like most industries, a large number of IT companies are tightening belts and cutting spending. Several studies indicate that the hardware business, in particular, is expected to be impacted. However, the adoption of collaborative applications and cloud services has been positive, followed by technologies such as security, Big Data, AI, IoT, where the impact seems to have been relatively minor.

The main reason is, of course, the need for a more digital and data driven organization. With employees working remotely, there is already an exponential rise in video calls/phone calls as an increasing number of people are holding meetings via apps or collaboration platforms. Digital media and over the top (OTT) content players are benefiting while virtual private networks (VPNs), cybersecurity, and data security are other technologies that will see a surge as most workforces operate remotely.

Cloud services will grow, boosted by higher usage of content, gaming downloads, video conferencing, and the impact of remote access on corporate networks. There will also be an increased focus on technologies such as artificial intelligence, Big Data, augmented reality, and virtual reality, among others.

Although the Covid-19 pandemic has certainly not triggered Industry 5.0, it has shown companies that Industry 4.0. digital workflows, robots, and automation are required in order to stay operational. It has accelerated the implementation, use, and innovation of IT and has exposed extant digitalization and datafication. This chapter provides an overview of the relevant trends and developments on international, national, and regional levels. The first section contains an overview of the most important IT & Data Science policies, while the second section contains an overview of the most dominant IT trends and developments.

A. Digitalization and policies

Much work is being done by the authorities to adapt and incorporate new technologies for digitalizing the world. Information technology and communications are considered among the most important issues in the digital era. New services, enterprises, and startups are being created that change the way established companies drive the market. IT introduces a disruptive point of view to business models and daily tasks.

These changes demand that markets, companies, and the authorities also adapt, which is why it is such a point of focus.

The challenge is not just restricted to interventions by governments. Both citizens and companies play an important role in this move towards a digital environment, encouraging the IT sector to create eminence in the global context.

This section is divided according to the following three main policy levels:

1. On an international level: the European Union
2. On a national level: the Netherlands
3. On a regional level: Brabant and Brainport Eindhoven in the Netherlands

1. On an international level: the European Union

NEXT GENERATION EU

To help repair the economic and social damage caused by the coronavirus pandemic, the European Commission, the European Parliament, and EU leaders have agreed on a recovery plan that will lead the way out of the crisis and lay the foundations for a modern and more sustainable Europe.

The EU's long-term budget, coupled with the NextGenerationEU initiative, a temporary instrument designed to boost the recovery, will be the largest stimulus package ever financed under the EU. A total of ¤1.8 trillion will help rebuild a post-Covid-19 Europe. It will be a greener, more digital, and more resilient Europe.
The new long-term budget will increase flexibility mechanisms to guarantee the capacity to address unforeseen needs. It is a budget not only for today's realities but also for tomorrow's uncertainties.

On 10 November 2020, an agreement was reached between the European Parliament and EU member states in the Council on the next long-term EU budget and NextGenerationEU. This agreement will boost specific programs under the long-term 2021-2027 budget by a total of ¤15 billion.

More than 50% of that amount will be devoted to modernization through:

research and innovation, via Horizon Europe:

fair climate and **digital transitions,** via the Just Transition Fund and the Digital Europe Program

preparedness, recovery, and resilience, via the Recovery and Resilience Facility, rescEU and a new health program, EU4Health

One element that is already important but will now receive even greater attention is the **digital transformation** of the European Union. A European approach to digital transformation means empowering and including every citizen, strengthening the potential of every business, and meeting global challenges with the Union's core values.

THE EUROPEAN DIGITAL STRATEGY: SHAPING EUROPE'S DIGITAL FUTURE

The European digital strategy consists of three pillars to ensure that the EU sets the global standard for emerging technologies and remains the most open region for trade and investment in the world. These three pillars are:

1. Technology that works for people

Development, deployment, and uptake of technology that makes a real difference to people's daily lives. A strong and competitive economy that masters and shapes technology in a way that respects European values. These focus technologies are:

- Digital skills and jobs
- Artificial intelligence, cloud computing and blockchain
- High-performance computing and quantum technologies
- Connectivity
- 5G and Internet of Things
- Cybersecurity
- Digital inclusion
- Photonics and electronics

2. A fair and competitive digital economy

A frictionless single market, where companies of all sizes and in any industry can compete on equal terms, and can develop, market, and use digital technologies, products, and services at a scale that boosts their productivity and global competitiveness, and consumers can be confident that their rights are respected.

- Data
- Online platforms and eCommerce
- Copyright
- Digitizing European industry
- Startup Europe
- The Digital Economy and Society Index (DESI)

3. An open, democratic, and sustainable digital society

A trustworthy environment in which citizens are empowered in how they act and interact, and for the data they provide both online and offline. A European approach to digital transformation that enhances its democratic values, respects fundamental rights, and contributes to a sustainable, climate-neutral, and resource-efficient economy.

- Disinformation
- Media and digital culture
- Trust and ePrivacy
- eHealth, eGovernment
- Smart cities
- Safer internet
- Women in IT

The European Union's digitalization strategy is set out in three programs:

PROGRAM 1:
EUROPE INVESTING IN DIGITAL:
THE DIGITAL EUROPE PROGRAM 2021 -2027

As part of the next long-term EU budget – the Multiannual Financial Framework – the Commission has proposed Digital Europe, a program focused on building the strategic digital capacities of the EU and on facilitating the wide deployment of digital technologies. With a planned overall budget of ¤8.2 billion (in 2018 prices, ¤9.2 billion in current prices), it will shape and support the digital transformation of Europe's society and economy.

The program will boost investments in:

- Supercomputing (¤2.4 billion)
- Artificial intelligence (¤2.2 billion)
- Cybersecurity (¤1.8 billion)
- Advanced digital skills (¤600 million)
- Ensuring a wide use of digital technologies across the economy and society, including through Digital Innovation Hubs (¤1.2 billion)

European Digital Innovation Hubs (EDIHs) function as one-stop shops that help companies dynamically respond to digital challenges and become more competitive. They also provide innovation services, such as financing advice, training, and skills development, that are needed for a successful digital transformation.
Its goal is to improve Europe's competitiveness in the global digital economy and achieve technological sovereignty. It will do this by deploying and capacity-building new digital technologies in order to support digital transformation to guarantee high quality public services benefiting citizens and businesses.

Digital Europe will complement other EU programs, such as the Connecting Europe Facility for digital infrastructure, as well as the Horizon Europe program for research and innovation.

PROGRAM 2:
HORIZON EUROPE: RESEARCH & INNOVATION

Horizon Europe is the EU's key funding program for research and innovation and, with a budget of ¤95.5 billion, its vision is to create a sustainable, fair, and prosperous future for people and planet based on European values.

- Tackling climate change
- Helping to achieve sustainable development goals (SDGs)
- Boosting the Union's competitiveness and growth

The program facilitates collaboration and strengthens the impact of research and innovation in developing, supporting, and implementing EU policies while tackling global challenges. It supports creating and improving the dissemination of high-quality knowledge and technologies.

It creates jobs, fully engages the EU's talent pool, boosts economic growth, promotes industrial competitiveness, and optimizes investment impact within a strengthened European Research Area. Legal entities from the EU and associated member states can all participate.

The Covid-19 pandemic and its social and economic consequences have highlighted the importance of digitalization across all areas of society and the economy in the EU. New technologies have kept businesses and public services running and our family and social bonds together. Today the data economy is already at the heart of innovation and job creation. The European Union wants to empower European citizens through digital solutions rooted in common values, enriching the lives of all.

Horizon Europe will help shape innovative technologies and solutions for healthcare, cultural heritage, critical infrastructure protection, cybersecurity and data protection, the improvement of skills and inclusive growth, and jobs. Businesses need technologies and solutions that enable them to start up, scale up, pool and use data, innovate, and compete or cooperate on fair terms.

Horizon Europe will help secure the open strategic autonomy of Europe and its global leadership in digital and emerging enabling technologies. Europe will become more resilient and independent through investments in strategic parts of the digital and other key supply chains and by supporting the development and uptake of new technologies and the green and digital transformation of industrial ecosystems, diversifying our key supply chains, supporting technological sovereignty where it matters, and keeping the flow of innovation going. The digital and green transitions also mean a unique opportunity to decouple resource use (water, land, biodiversity, materials, and energy) and emissions such as greenhouse gases (GHG) and pollutants from socio-economic development and growth.

Impact areas

- A competitive and secure data-economy
- Industrial leadership in key and emerging technologies that work for people
- Secure and cybersecure digital technology
- High quality digital services for all

Five clusters, in particular, will contribute to this orientation and accelerate and steer the digital and green transitions, enriching the lives of all European citizens through novel digital technologies rooted in common values.

Cluster 1
(Health) will increase Europe's autonomy in delivering healthcare by contributing to safer, trusted, more effective and efficient, affordable and cost-effective tools, technologies, and digital solutions for improved (personalized) health promotion and disease prevention, diagnosis, treatment, and monitoring for better health outcomes and well-being, by integrating people in the design and decision-making processes, based on expected health outcomes and the potential risks involved.

Cluster 2
(Culture, Creativity, and Inclusive society) will support sustainable innovation, job creation, improved working conditions, and a European sense of belonging through a continuous engagement with society, citizens, social partners, and economic industries.

Cluster 3
(Civil security for society) will contribute to establishing, deploying, and stewarding resilient critical digital and physical infrastructure, both private and public.

Cluster 4
(Digital, Industry, and Space) will support the development and mastery of the digital and key enabling technologies of the future.

Cluster 5
(Climate, Energy, and Mobility) will support Europe's green transition based on competitive European industrial and service value chains, particularly within the energy and mobility industries, which represent markets that are predicted to grow globally at a substantial pace.

PROGRAM 3:
CONNECTING EUROPE FACILITY (CEF)

CEF is complementary to the HORIZON 2020 Program for Research and Innovation. While the CEF focuses on building modern infrastructure (transport, energy, and telecommunications), EU-funded H2020 actions develop and test new clean energy, transport, and digital technologies that can be used in the next generation of modern infrastructure.

The European Union's policy on trans-European networks for transport, energy, and telecommunication infrastructure aims to connect member states and regions, ensure a sustainable and efficient transport infrastructure, and support a connected and interoperable Digital Single Market and a resilient Energy Union with a forward-looking climate policy. By providing targeted EU investment across all member states and beyond, the Connecting Europe Facility (CEF) is a flagship funding program with a key role in supporting the European Commission's priorities related to smart, sustainable, and inclusive growth, and the EU's Europe 2020 Strategy objectives in respect of energy and climate policy. With an available budget of 30.5 billion between 2014 and 2020, the program contributes to strengthening the competitiveness of the EU economy and its transition to climate neutrality.

The goal of the program is to support the development of high performance, sustainable, and efficiently interconnected trans-European networks in the fields of research and innovation. It also supports complementarity with the European structural and investment funds, such as the Cohesion Fund, as well as the European Fund for strategic transport, energy, and digital services. Within these three industries, specific funding objectives have been established.

For the purpose of this study, we will look at the telecommunications industry, in which the following building blocks have been defined:

- **eTranslation:** Exchanging information across language barriers in the EU member states
- **eDelivery:** Supporting electronic registered delivery of data and documents
- **eInvoicing:** Helping public entities adopt the European standard on electronic invoicing
- **eID:** Extending the use of online services to citizens of other EU member states through mutual recognition of national electronic identification
- **eSignature:** Creating and verifying electronic signatures

CEF Digital Service Infrastructures (DSIs) play a key role in supporting member states to comply with EU regulations and directives and facilitating coordination among member states to share data, develop standards, and enable the interoperability of an ecosystem of digital solutions they have developed at national level. This has resulted in faster and more efficient online public and cross-border services for the benefit of citizens, businesses, and public agencies across Europe.


CEF
Telecom
funds

2. On a national level: the Netherlands

In June 2018 the State Secretary for Economic Affairs and Climate Policy, the Minister of Justice and Security, and the State Secretary of the Interior and Kingdom Relations presented the **2018-2021 Dutch Digitalization Strategy.** Through this strategy, the government aims to maintain the Netherlands' position in Europe's digital vanguard. Making use of the opportunities that digitalization offers and addressing the risks requires cooperation between the business community, public authorities, knowledge institutes, and civil society organizations. The Dutch Digitalization Strategy is a government-wide approach. *In June 2020 the update of this strategy was presented, called "the 2020 Dutch Digitalization Strategy".*

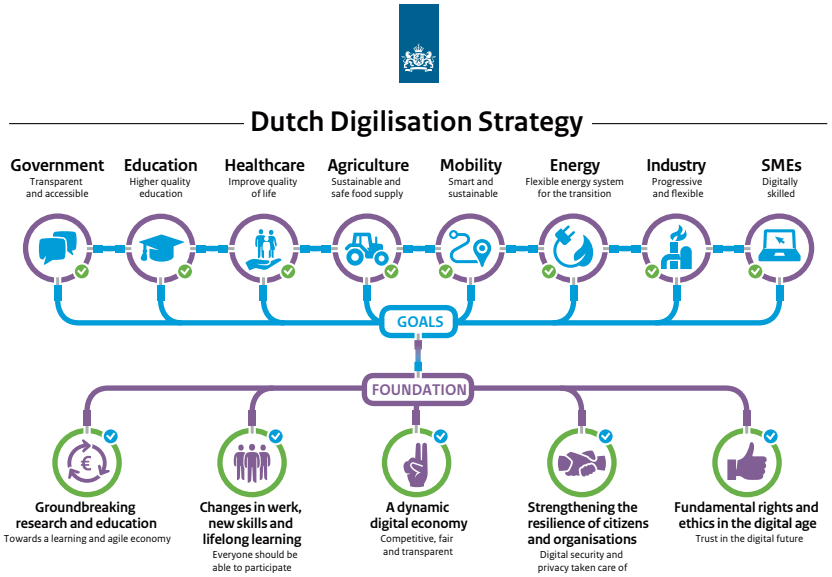


Figure: Dutch Digitalization Strategy

Source and more info: www.government.nl/documents/reports/2018/06/01/dutch-digitalisation-strategy

THE 2020 DUTCH DIGITALIZATION STRATEGY

The government is committed to a two-pronged approach:

1. Leveraging social and economic opportunities (acceleration)

An important part of digitalization is taking place in socially-related industries, in which the government plays a relatively large role. This includes healthcare, mobility, energy, and the AgriFood industry. The digitalization of public administration processes is also an important task. The challenge for the authorities is to speed up and support digital transition in these fields.

2. Strengthening the foundation (basic conditions)

The foundation for digitalization – including privacy protection, cyber-security, digital skills, and fair competition – must be further strengthened. The government will focus on five key focus areas so that citizens and businesses can take advantage of the opportunities offered by digitalization. The focus in this strategy lies on the following six priority themes:

1. Artificial Intelligence
2. Data sharing and access
3. Digital skills and inclusion
4. Digital government
5. Digital connectivity
6. Digital resilience

KNOWLEDGE AND INNOVATION AGENDA – DUTCH DIGITAL DELTA

The Dutch Digital Knowledge and Innovation Agenda is built around four societal challenges and five digital key technologies. These key technologies must contribute to improve the societal challenges.

The societal challenges are:

1. Energy transition and sustainability
2. Agriculture, water, and nutrition
3. Health and care
4. Safety

The digital key technologies are:

1. Big Data

A two-year program, Commit2data, that supports projects in using big data in societal challenges. Projects are performed in six regional data innovation hubs.

2. Blockchain

A coalition of parties (Dutch Blockchain Coalition) that develops and applies blockchain technology. The following lines of action are defined: developing blockchain building blocks: digital identities, realizing the conditions for utilizing blockchain, developing and realizing the Human Capital Agenda.
Areas of application that are explored are: self-sovereign identity, logistics, academic certificates and diplomas, pensions, compliance by design, and mortgages.

3. Artificial intelligence

NLAICoalition is a coalition of companies and knowledge institutes that work together to develop applications for AI technology. The following building blocks are defined: data sharing, human capital, research and innovation, societal acceptance, and inclusion of startups and scaleups. The focus in applications lies on the following industries: agriculture and nutrition, culture, defense, education and, energy and sustainability.

4. Cybersecurity

A multi-year program will be developed to strengthen the cybersecurity of businesses, citizens, and governments.

5. 5G

A 5G network is currently being rolled out across the Netherlands, opening up a whole new range of possibilities for wireless services that can tackle economic and societal challenges.

3. On a regional level: Brabant & Brainport Eindhoven in the Netherlands

Brabant is competitively placed as a top knowledge and innovation region. To maintain this position and to grow to become a more sustainable and prosperous economy, Brabant aims to further bolster its international competitiveness, sustainability, and innovative economy. Digitalization, of which datafication is a part, is becoming increasingly important for maintaining Brabant's competitiveness.

The province has an excellent digital position in Europe due to its digital infrastructure, which is the best in Europe, the fact that 98% of the population have access to the internet, the population of the Netherlands is IT-minded, and the fact that the province has a high-quality knowledge infrastructure and plenty of opportunities to facilitate startups. But it is not a given that Brabant will maintain that favorable position. Other countries and regions are constantly developing and investing heavily in their knowledge levels and ecosystems for innovation.

The province has the ambition and ability to become the European leader in the data and digitalization economy. Brabant not only wants to exploit the opportunities offered by technological developments, digitization, and artificial intelligence, but to actually lead the way in specific areas. Brabant aims to boost data connectivity and business activities and develop digital skills and talent. The province is presently working on a new digital strategy, which will be launched in the first quarter of 2021.

BRABANT'S 2030 ECONOMIC POLICY FRAMEWORK

Brabant's 2030 Economic Policy Framework presents the vision for the economic future of the province. Brabant must be able to respond flexibly to major challenges, such as sustainability, energy and circularity, digitalization and datafication, and demographics. The province's innovation policy is mission-driven, which means that the benchmark for the actions is the extent to which new initiatives contribute to the broad social challenges.
Brabant focuses on three main objectives to become the leading data and digitalization economy:

1. **Digital connectivity** (to accelerate the development of the next generation of digital connections/infrastructure; a reliable, secure, and affordable digital infrastructure is a precondition for a successful digitization agenda, with the BrabantRing secure data exchange initiative serving as a good example)

2. **Digital economy** (Brabant aims to further strengthen its internationally competitive innovative economy over the next 10 years (through an administrative undertaking); successful digitization and use of data are essential preconditions for this)

3. **Digital Skills & Talent** (Brabant aims to use its already strong business community and knowledge infrastructure to become the leading digital province; the focus is on encouraging the development of digital/data knowledge, and an important part of the policy involves bolstering education and training at all levels)

The following five focus areas are prioritized for the further development and acceleration of digitalization in order to become the leading digital economy in Europe:

1. Smart industry
2. Growth of the data-driven economy in the priority clusters (HTSM, Life Science & Health, AgriFood, and Mobility)
3. Digitalization of SMEs
4. Resilience and cybersecurity of SMEs
5. Labor market and talent

Moreover, Brabant aims to accelerate work on the following social challenges through the use of digital technologies:

6. Public order and safety
7. AgriFood transition (smart farming)
8. Energy transition
9. Smart mobility
10. e-Health (smart health)

The region has defined the following key technology areas:

1. Big Data
2. Photonics
3. Artificial intelligence
4. Robotics

B. Dominant trends & developments by market players

Below we outline the latest IT trends, based on recent reports by Atos, Gartner, and Rabobank. In addition, a number of trends were mentioned in the interviews we conducted.

1. ATOS Origin, Look Out 2020, Business trends

Atos Origin has published a Look Out report on business trends where IT plays a major role. The report draws a distinction between the following strategic signals together with 12 challenges and opportunities for the future:

CUSTOMER-CENTRICITY

Generations Y and Z reinventing customer behavior: Already representing two-thirds of consumers, always connected, social and impatient, these digital natives only care about seamless simplicity and experience. They have a non-linear path to purchasing and low brand-loyalty.

B2Me is the future of B2C: The digital approach means that mass personalization has succeeded in the mass market. Automation, as-a-service and 3D printing promise to make one-to-one marketing and production more than just a great concept and turn it into fundamental reality.

Intelligent assistants become autonomous: Google Assistant, Alexa, Siri, and others are already beginning to make purchases on behalf of their users. This promises a fundamental revolution- as is already the case in trading today, tomorrow's billions of "customers" may not just be humans...

NEW BUSINESS MODELS

- Products become services: By enabling connected services and new business models, such as the sharing or as-a-service economy, "servitization" is transforming all industries at a fundamental level. Going far beyond B2C, it may disintermediate or commoditize numerous players across many verticals
- Mega-platforms attract ecosystems: A networked world has powerful characteristics, and while it favors a long tail of small and agile players, the network gravity effect is also driving the rise of overarching mega-players. By 2022, mega-platforms will feature in 60% of industries.
- Vertical frontiers blur: As players regroup around customer-centric ecosystems and services, traditional business frontiers will tend to fade. In many industries, up to 40% of revenue in the next decade will come from new services.

INDUSTRY 4.0

- The gig economy replaces Taylorism: Popularized by Uber and Airbnb, the sharing economy is about much more than just taxis or accommodation. It will be seen wherever marketplaces flourish, including in services and even consulting. Up to 30% of jobs may be leveraged by freelancers by 2025
- Enterprises become liquid: On both sides of the spectrum, digital favors the behemoths and the constellations of microstructures adapting to markets in real-time through market-places. In tomorrow's networked world, enterprise organizations' practices will change to favor fluidity and scalability. The era of the liquid enterprise has arrived.
- Robo-sourcing will revolutionize work: After offshoring, automation promises to dramatically reduce costs even further. By 2025, 40% of current tasks could be automated, changing the nature of work, with humans and robots working side by side.

CYBERSECURITY

- Cybersecurity is the new battlefield: With the cost of cybercrime set to rise to $1 trillion and more in the coming years, cybersecurity has become much more than a risk – it's the next strategic threat. What's at stake is not just making trust a differentiator or risk being precluded, but ensuring absolute defense and sovereignty.
- Info wars are on the rise: As data becomes the new gold, information property, control, and legitimacy become crucial for countries, businesses, and people. Tomorrow's fourth generation wars may be informational as well as economic and military. According to analysts, 50% of information consumed in 2022 may be fake news, requiring organizations to set up powerful data protection measures.
- Transparency is the new (monetized) ethic: A reputation takes years to build, and on social networks it may be lost in seconds. In tomorrow's hyperconnected world transparency and traceability will be more essential than ever. They will be more than a requirement – they may well be a precondition for survival.

Source: Atos Origin, Look Out 2020

2. Gartner Top Strategic Technology Trends 2021

Gartner distinguishes three main strategic technology trends, each with three components

1. People centricity

- Internet of Behaviors (IoB): using personal data to influence behavior, such as crime-prevention
- Total experience: using data and IT to optimize user, customer, or worker experience throughout procedures
- Privacy-enhancing computation: technology that enables organizations to process privacy-sensitive data such as confidential computing, differential privacy, homomorphic encryption, secure multiparty computation, zero-knowledge proofs, private set intersection, and private information retrieval

2. Location independence

- Distributed cloud: public cloud solutions for different physical locations
- Anywhere operations: technology that supports customers and employees everywhere
- Cybersecurity mesh: a distributed architectural approach to scalable, flexible, and reliable cybersecurity control

3. Resilient delivery

- Intelligent composable business: architecture that enables better access to information, can augment that information with new insights and is composable modular, and can change and respond more quickly as decisions are made;
- AI engineering: developing robust AI engineering that facilitates the performance, scalability, interpretability, and reliability of AI models
- Hyperautomation: processes in which businesses automate as many business and IT processes as possible using tools such as AI, machine learning, event-driven software, robotic process automation, and other types of decision-making process and task-automation tools

Source: Gartner Top Strategic Technology Trends 2021

3. Rabobank Technology Trend Report 2020, Tech Lab, Innovation & Strategy Hub

Rabobank Tech Lab distinguishes between the following eight important technological developments:

1. Artificial Intelligence

The enormous increase in computational power, the explosion of available data, and the increasing number of data professionals in the workforce has led to an enormous growth in AI. AI will change the way people live and work. It will lead to enhanced judgement, improved interaction, greater degrees of trust, and products that are far more intelligent. Data quality and privacy are both still challenging issues when it comes to AI. AI algorithms are still far from perfect – in fact, the idea of 100% accurate algorithms that can operate entirely on their own without the need for human intervention or decision-making is still a far-off goal. Furthermore, many organizations today battle with the amount of data and the level of data quality needed for solid AI applications.

2. Blockchain

In short, blockchain enables entities (companies, individuals, things) to store information securely while enjoying a degree of anonymity through the use of pseudonyms.

The chief advantages of blockchain technology include:

- A blockchain-enabled platform is 100% transparent and is constantly updated
- Blockchain networks decrease dependency on trusted third parties (the so-called middleman)
- Blockchain exchanges are fully verifiable – transactions can be traced back to their inception
- Transactions within the network are executed securely via smart contracts and rely on the use of pseudonyms; computer protocols are used to facilitate, verify, and enforce the near real-time negotiation of a contract, and so no human intervention is needed. Such decentralized self-executing contracts are expected to take off in the foreseeable future

The key challenges in blockchain

Despite rapid developments, three major challenges continue to hinder the widespread adoption of blockchain solutions: limited scalability, the competition paradox, and privacy challenges.

Scalability: in blockchain technology every transaction is recorded and the complete history of transactions is stored. This leads to an increasing amount of data that has to be stored with every transaction, which results in the system slowing down, increasing storage demands, and energy consumption.

Competition paradox

Blockchain technology forces competing parties to cooperate equally while data is stored at all parties. They have to redefine markets and improve global industries together.

Privacy

The fact that blockchain networks use eternal memory poses yet another challenge – the issue of privacy. This is particularly problematic in light of the General Data Protection Regulation (GDPR) – how can we justify information and transactions being memorized forever? While the GDPR enforces people's right "to be forgotten", blockchain technology makes forgetting impossible. It seems to contradict the way the world is headed. The question is, how can blockchain and privacy coexist? We know that there are answers to this conundrum and many people are working hard to find them, but we haven't yet

discovered an ultimate solution. Aside from these three key challenges, there is also the struggle to ensure that all data stored in a blockchain is actually reliable. Involved parties simply have to take it on faith that the information is accurate and, for obvious reasons, that is not always easy to do.

3. Extended Reality (XR)

Extended reality consists of virtual reality (VR) and augmented reality (AR). Virtual and augmented reality solutions continue to minimize the distance that lies between users and information, experiences, and even people. While XR applications will develop to offer experiences that are increasingly realistic and "credible", the necessary hardware will, over time, also become cheaper and more accessible. For obvious reasons, this will remove barriers that stand in the way of the growth of XR, and not only in the gaming industry. XR-based solutions and innovations are gaining traction throughout the business world and are starting to feature in a growing number of customer-related products and services.

4. Internet of Things

The Internet of Things (IoT) is really the synthesis of a number of different technological advancements. Essentially, IoT refers to a network of uniquely identifiable "things" that can communicate with each other without a need for human interaction or intervention.

The IoT relies on an ecosystem that is built around a particular environment, be it in a home, in a factory, on a farm or in a city's streets. There are five essential components in any IoT ecosystem. These are:

- Hardware, such as built-in chipsets and sensors
- Networks that connect IoT solutions, thereby enabling data transmission
- Remotes/interfaces through which the IoT solution can be managed (such as a smartphone, tablet, computer, smartwatch, or smart speaker)
- An IoT platform – a central IT system that transmits messages between devices and stores data
- Security protocols that ensure the IoT solution remains protected

The rapid development of IoT presents a number of challenges. These include:

1. Security threats – enterprises have been building vast interconnected ecosystems for some time now, but only 29% of businesses and IT executives report they are confident that their ecosystems are secure
2. Privacy issues – devices in your house gather a lot of information; what happens if this data is improperly shared or misused?
3. Identity management – how can a platform be sure that a machine truly is who it says it is?
4. The standardization of API platforms/IoT protocols – some of them are closed, some slightly more open

6. Next Generation Communication Networks: 5G and LoRa

The two most important new next-generation communication technologies are 5G and LoRa. 5G is the next-generation cellular standard and long-awaited successor to 4G. It is a true game-changer – speeds are up to a hundred times faster than those offered by 4G. 5G will offer unprecedented global coverage with high bandwidth at a reasonable cost. Whereas the upgrade from 3G to 4G merely entailed more bandwidth and a shift to a different frequency, the move from 4G to 5G encompasses a number of fundamental changes that will have a significant impact on the world and create far more opportunities. 5G is designed to support three major types of traffic:

- Enhanced Mobile Broadband (eMBB)
- Ultra-Reliable Low-Latency Communications (URLLC)
- Massive Machine-Type Communications (mMTC)

The challenges ahead for 5G:

- In crowded areas, 5G implementation is not easy, and we would need to install a significantly higher number of amplifiers and antennas
- The 5G chip market is in the midst of the trade war between the US and China, so chips are currently hard to come by
- Although not proven, 5G is considered by many people to be a health risk due to the increase of radio waves in the ether. Protests against 5G may delay, or even impede, implementation

LoRa stands for Long Range and refers to the long-range low-power wireless platform that has become the de facto technology for global IoT networks.

7. Quantum computing

Quantum computing (QC) entails a fundamentally different approach to computing than that adopted by traditional computers of today. Quantum computers do not use transistors or classical bits but are based on qubits (quantum bits). Quantum computers can perform complex computations in a fraction of time it would take traditional computers to run the same calculations.
The key challenges facing quantum computing.
There are reasons why QC has not quite yet taken flight, even though there has been ongoing research in this field for the past three decades. Some of these include:

- It is incredibly difficult to get access to a quantum computer. There are currently only a few in existence and they are located in the offices of some of the world's biggest companies and organizations (including NASA, Google, ExxonMobil, IBM, and CERN). Quantum computers are extremely expensive and very complex to build from a technical standpoint
- QC requires extremely low temperatures to function optimally. The cores of D-Wave quantum computers operate at -273 degrees Celsius, and so QC consumes an inordinate amount of energy
- The number of stable qubits is still low – a maximum of 50-100 unstable qubits or 10 stable qubits – and the error rate is still too high. As a result, our ability to apply QC in the real world remains very limited
- QC is radically different from traditional computation and requires a very different way of programming, of which we only have seen the beginnings

8. Secure multi-party computation

Despite referring to secure multi-party computation (SMPC) being an upcoming trend, the technology itself is anything but new. SMPC is a subfield of cryptography; it refers to a collection of cryptographic algorithms that enables multiple organizations to combine their data for analysis and intelligence, while ensuring that each participating company does not have access to the competitive or private data of any other business.

More specifically, some of the key concrete advantages of this trend include:

- It enables proprietary solution protection, allowing different parties to jointly execute a calculation while keeping their inputs secret from one another
- It offers security
- It enhances privacy
- It makes it impossible for other parties to monetize your data
- It empowers parties by giving them control, allowing them to determine who receives the output of the calculations (and who doesn't)

Challenge: the relationship between data sharing and data protection

9. Voice technology

Digital voice assistants (DVAs) exist in many different shapes and forms, with the most popular being built into smart speakers, smartphones and even cars. DVAs are built with software that combines large data sets with AI, leveraging machine learning and natural language processing (NLP).

Challenges for voice technology are language, privacy, and audience. Aside from the language challenge, privacy is also an issue. After all, personal assistants are always listening – often for the purpose of "quality assurance" – and can therefore record more information than users would like to be recorded.

Source: Rabobank Technology Trend report 2020, Tech Lab, Innovation & Strategy Hub

C. Trends and developments mentioned in the interviews

The following trends and developments were prominently referred to in the interviews for this study.

Big Data

Data collection, processing, enrichment, and analysis is nothing new, but the current advances are enormous developments. Not only is the amount of data available from sensors growing in leaps and bounds, but more and faster storage capacity is also available. Data that we could not use before is now usable and can be combined and translated into information with which we can improve all kinds of processes and products.

The four V's remain important and challenging in Big Data developments:

- **Volume:** the amount and the scale of the available data
- **Velocity:** at what speed can the data be communicated between sensors, databases, etc.?
- **Variety:** how many types of data are available and what data can be combined?
- **Veracity:** how much noise is there in the data, how large is the bandwidth of uncertainty? Bad data will lead to bad outcome and conclusions.

AI: Self-learning machines

AI also plays an increasingly important role in machine maintenance. Artificial models can be used to predict machine maintenance and computer models are built to simulate the running and lifetime of machines (digital twins).

Digital transformation

Digital transformation is the adoption of digital technology to transform services or businesses through replacing non-digital or manual processes with digital processes, or replacing older digital technology with newer digital technology. In addition to generating efficiency through automation, digital solutions may also enable new types of innovation and creativity, rather than simply enhancing and supporting traditional methods. The triple helix organizations are strongly committed to digital transformation in their policy, and numerous projects and programs are being set up to launch the process. There are four types of digital transformation: business process, business model, domain, and cultural/organizational transformation.

5G

The world is becoming increasingly connected. This applies to people, but also increasingly to devices and machines. The growth in the number of sensors, and the data they generate, and devices and machines that can communicate increasingly smartly with their environment and each other means evermore potentials for interaction between man and machine. Examples include lights that respond to the environment or self-driving cars. It is, of course, important that large amounts of data can be communicated quickly, and the 5G network provides much faster mobile internet than its 4G predecessor and increasingly necessitates IoT solutions. In the Netherlands, 5G is now being rolled out and there is much focus on the opportunities it will offer.

Cybersecurity: Zero-trust security

Because the world is increasingly interconnected and more and more data is available that can be misused by malicious parties, with far-reaching consequences, optimal security for all digital systems is a high priority.

Zero trust is a concept where nothing is trusted, whether within or without the boundaries of an organization, without first checking who and what is trying to connect. Zero trust means that someone you have let into a system cannot just move freely through the system. Each domain has its own "security guard" and its own security checks. In fact, conditional access to data and systems is granted on the basis of "the least rights".

10. SUMMARY OF BRABANT'S IT & DATA SCIENCE STRENGTHS

The economy in Brabant continues to grow. The secret of its success is a simple one – innovation and collaboration. With billion-dollar corporations such as Philips and ASML and countless innovative startups, the economy in Brabant has grown faster than any other region in the Netherlands for the past five years. The province is the perfect place for IT & Data Science companies, and is already home to many IT & Data Science initiatives and organizations that perform top-class work and set themselves apart from the market. The principal strengths of Brabant in the world of IT & Data Science can be summarized as follows:

A. IT talent: explosive growth and the presence of talent from excellent universities, knowledge institutes and education in IT & Data Science

As a knowledge-intensive industry, IT & Data Science depends heavily on talent resources, and the flourishing IT & Data Science ecosystem has driven up demand for talent even further. Talent and bright minds make all the difference in the province's knowledge economy, and that will continue to be the case. Developing, utilizing, retaining, and attracting IT talent is of utmost importance, which is also why the region prioritizes it. The province has invested heavily for decades in achieving and retaining its top knowledge economy position utilizing all the available talent.

And these investments have paid off. The Brabant region is the chief supplier in the Netherlands of highly educated IT talent. The region also has the steadiest rise in the graduates at all education levels in the Netherlands. Universities such as the Eindhoven University of Technology and the Fontys University of Applied Sciences are important providers of IT professionals.

These universities closely work together with the authorities and the local business community to offer connected study programs and to make its IT studies more appealing to Dutch and international students. The programs are not only adapted, but these partnerships also result in completely new innovative educational concepts, such as:

Fontys IT InnovationLab is a hybrid learning environment where co-creation and cooperation facilitate broader knowledge creation and transfer while also fulfilling personal learning goals through shared learning. By stimulating research and project-based learning in teams of students, teachers, professors, and business partners, Fontys has created a unique open learning environment for IT talent. In this hybrid learning setting, each participant is able to set his or her own learning goals and work towards enhancing and expanding their expertise.

JADS is one of those unique partnerships between the Province of Brabant, the Municipality of Den Bosch, Tilburg University, and Eindhoven University of Technology. At three different locations the study, research, and application of data science is brought together in bachelor's, master's, and PDEng programs, data science research centers, and existing ecosystems.

Aside from these facilities, companies in the region such as Sioux, NTS, and ASML are all building their own campuses with a focus on training and education.

Talent does not only have to come from Brabant/the Netherlands. For many years Brabant has welcomed educated, skilled, and talented international knowledge workers to the region with its interesting jobs in multinational companies and in universities. The strategic location in Europe and the country's second-largest airport in Eindhoven, along with the relatively low cost of living, makes it an ideal choice for international talent. The only Dutch university that is presently still actively recruiting foreign students is the **Eindhoven University of Technology**.

The Brainport Talent Attraction Program is one of the examples of active acquisition of Tech and IT Talent in the region.

Talent Attraction Program statistics (2019):

- Total reach of 2.2 million technicians and IT professionals worldwide
- Supported 141 SMEs in attracting and retaining talent

ICT STUDENTS 2020

3410 graduates | **5121** new students

BRABANT SHOWS THE HIGHEST AND MOST STEADY GROWTH OF ICT TALENT

Relative growth of both new students and graduates in all education levels is above the national average.

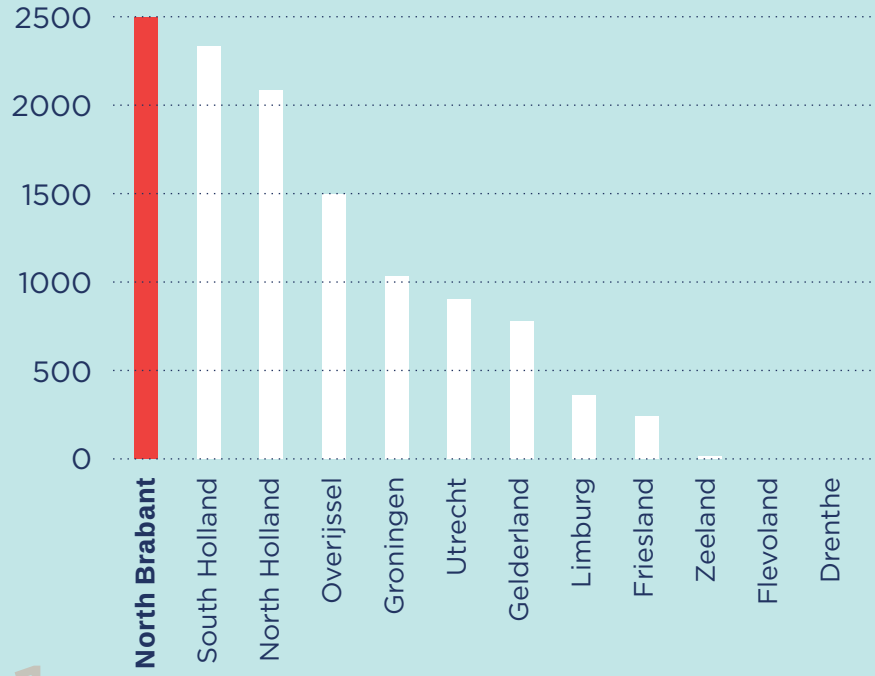
NEW STUDENTS
Average growth from 2007

Noord-Brabant	**7,1%**
Utrecht	6,2%
Noord-Holland	6,0%
Overijssel	5,8%
Groningen	5,7%
Zuid-Holland	5,0%
Gelderland	3,6%
Flevoland	3,0%
Limburg	3,0%
Zeeland	2,9%
Friesland	2,5%
Drenthe	-1,2%

GRADUATES
Average growth from 2007

Noord-Brabant	**5,3%**
Noord-Holland	4,4%
Utrecht	4,4%
Groningen	4,2%
Gelderland	3,7%
Zuid-Holland	2,9%
Friesland	1,4%
Overijssel	1,3%
Drenthe	1,1%
Flevoland	0,3%
Limburg	0,1%
Zeeland	-0,1%

BRABANT BOOSTS THE MOST HIGHLY EDUCATED ICT TALENT in the Netherlands



WOMEN IN ICT 2020

Brabant has the largest and most steadyyearly growth of new female students.

graduates

599

18% of all students

Average Yearly growth from 2007

12%

new students

1109

22% of all students

Average Yearly growth from 2007

15%

MOST IMPORTANT UNIVERSITIES:

Fontys University of Applied sciences

#1 most graduates in the Netherlands

2nd most new students

Tilburg University

#2 most ICT graduates in NL

3rd most new students

The talent pool of Brabant excels in a large variety of skills.

TOP SKILLS ARE:

Embedded software / Systems
Robotics / Robot Programming
Automation software
Simulation software
Low Level Programming / Assembly Language programming
Real time operating systems software
Ada Programming
SAP software

EXAMPLE OF IT RELATED COURSES PER UNIVERSITY:

Fontys

General IT students
Automotive software
Business informatics

Share graduates 12%
Share new students 12%

BUAS

Game Developers
Data Sciece & AI
Media Innovations

Share graduates 3%
Share new students 2%

TU/e

Embedded Systems & Software
Computer Science & Engineering
AI & Data Acience in Engineering Systems
Industrial and Applied Mathematics
Medical Imaging

Share graduates 8%
Share new students 8%

Avans

General Computer ScienceBusiness & IT Animation

Share graduates 10%
Share new students 9%

Tilburg University

Cognitive Science & AI
Data Science & Society
Econometrics and Mathematical Economics

Share graduates 13%
Share new students 11%

JADS

Data Science Students

AVERAGE GROWTH 2007 - 2020

GRADUATES

6%	4%	27%	12%	10%
Fontys Hogeschool	Avans Hogeschool	Breda University of Applied Sciences	Technical University of Eindhoven	Tilburg University

NEW STUDENTS

9%	7%	7%	13%	13%
Fontys Hogeschool	Avans Hogeschool	Breda University of Applied Sciences	Technical University Eindhoven	Tilburg University

B. Highly-developed clusters, campuses, and joint innovation facilities with distinct expertise and resources for IT & Data Science in specific industries

Brabant is home to a number of open-innovation campuses. These campuses consist of four key elements: a focus on R&D and/or technology-driven activities, high-quality locations and research facilities, the presence of respected knowledge institutes, and active, open innovation. Many of the campuses in Brabant have an industry-specific focus where IT & Data Science plays an important role.

These campuses are home to multiple IT & Data Science-specific field labs. Field labs are real-life testing sites where a range of parties join forces to develop, test, learn to implement, and scale up new technologies for commercial applications. These field labs bring together researchers, students, entrepreneurs, and companies and enable them to accelerate IT & Data Science innovations for a specific industry or application. Thanks to the close involvement of researchers, the industry, government agencies, and end-users, these innovations can be brought to society at an accelerated pace.

	Sector							Goal of the lab				Technology								
Fieldlab & Shared Facilities	HTSM	LS&H	Agrifood	Automotive	Logistics	Maintenance	Smart city/living	Experiment & Test	Training & Education	Demonstration	Network	Cloud	AI	VR	5G	IoT	Data Technologien	Cyber Security	Blockchain	Robotics
Advanced Manufacturing Logistics	●							●	●		●		●	●	●	●				●
Flexible Manufacturing	●							●	●		●		●	●	●	●		●	●	●
Multi- M3D field lab	●							●	●	●	●		●	●	●	●				●
High Tech Software Cluster	●								●	●	●		●	●	●	●		●	●	●
Smart connected supplier network	●				●						●								●	
5G Hub HTC		●						●	●	●	●		●	●	●		●		●	
5G Manufacturing Industry field lab	●							●	●	●					●					
5G Automotive field lab				●	●			●		●					●					
Cyber Resilience Center									●		●						●			
National Experimental Garden Precision Agriculture			●					●	●	●	●		●	●	●	●				●
Social Cohesion field lab								●			●							●		
BrainBloc								●	●	●	●		●	●		●			●	
Composite Maintenance and Repair field lab								●			●			●						
Smart Living City Lab								●	●	●				●		●				
Data science for logistics innovation (DALI)					●		●	●	●	●			●	●						
Breda Robotics	●		●		●			●	●	●	●			●		●				●
VIA APPIA	●							●	●	●	●		●					●		
"Samen"-Together	●					●			●		●			●	●		●		●	
Capella field lab	●							●	●	●	●			●		●				
CAMPIONE 2 field lab	●					●		●	●	●	●			●		●		●		●
Data Value Center Smart Industry	●								●		●			●						
SPARK Industry Field LAB	●							●	●	●	●			●		●		●		●
Smart District								●		●				●	●	●				
Autonomous Drones – Flying Forward						●	●	●		●			●	●	●			●		
ICAI: e/MTIC AI-Lab		●						●	●		●		●	●						
ICAI: Mobility Lab				●	●			●	●		●		●	●						
ICAI: AIMM Lab	●					●		●	●		●		●	●						●
ICAI: FAST Lab	●							●	●		●		●	●						
ICAI: KPN Responsible AI Lab	●							●	●		●		●	●						
ICAI: Masterminds Lab	●				●	●		●	●	●			●	●				●		●
Industrie 4.0 De Peel	●												●	●						
AI Innovation Center	●	●							●	●	●		●	●						
Agro-proeftuin De Peel'			●					●	●	●	●		●	●						

C. Brainport Eindhoven is one of the smartest most innovative IT & Data Science clusters in the world

Brainport Eindhoven has a rich history of innovative high-tech solutions. Innovation is in the DNA of the region, and the Brainport Eindhoven region is Europe's foremost innovation cluster for data technology patents, such as the Internet of Things (IoT), Big Data, 5G, and artificial intelligence (AI).

In global rankings, Eindhoven holds 15th place. The region boasts a high degree of specialization in various 4IR technologies, such as 3D systems, smart healthcare applications, and smart agriculture. A large variety of companies apply for IT & Data Science patents in the region, including Philips, Signify, ASML, Here, and NXP.

The Brainport Eindhoven region is home to some of the most advanced software in the world, software that drives many of the innovative and complex products in the high-tech, medical, AgriFood, and mobility industries. This software embodies the competitive edge that enables Dutch companies to compete and win on the world stage.

D. The distinctive and constructive Brabant cooperative model of open innovation which goes beyond borders

Brabant has a distinctly strong culture, history, and tradition in informal constructive cooperation based on trust and open innovation. The advantage of this culture is that cooperation, whether informal and/or professional and intensive, comes naturally in the region. Opinion leaders in the region in business, science, and government publicly invite interested parties to contact them and explore mutual interests.

In keywords: building partnerships in the region is a quick and fluid process, and faster than anywhere else in the Netherlands. Outsiders seeking to join in and actually contribute will quickly and easily fit in and reap the benefits.

Next to these partnerships, the region is also home to the IT & Data Science-focused international innovation cluster organizations ITEA and ARTEMIS IA. These two innovation cluster organizations both have offices at the High Tech Campus and have an impressive track record in successful funded innovation projects. The main goal of both is to enable a wide international community of large industry, SMEs, startups, academia, and customer organizations to collaborate in industry and application-specific innovation projects. And that is what the Brabant companies, both large and small, do best.

Almost every type of organization in the ecosystem in Brabant participates in these innovative international IT & Data Science projects, from the large companies such as Philips, FEI, ASML, TNO, and NXP to the Eindhoven University of Technology and the smaller specialized companies, including Unit040, Amber, and GrAI Matter Labs. Even PSV Eindhoven football club is currently participating in an international innovation project known as INNO4HEALTH.

Example innovation project: Inno4Health

The project is led by Philips, with PSV, Philips, TU/e, IMEC, Maxima Medical Center, St Anna Hospital, TNO, and 19 other partners participating.

Inno4Health aims to stimulate innovation in continuous health and fitness monitoring to inform patients and their treating physicians on the readiness associated with surgery and the ability to recover rapidly from invasive treatment. In sports the same technology will be used to continuously assess fitness and health to provide information to athletes and their coaches and to help them optimize performance when competing. Inno4Health will be a pioneer in terms of comprehensive data capturing and interpretation outside of the hospital and training fields. Inno4Health will foster advances in sensing technologies, emerging IoT communication capabilities, and artificial intelligence for embedded data interpretation and user analytics.

Inno4Health will create innovative design for wearable sensors (in-soles, shirts, plasters) that address the usability needs of both patients and athletes. Wearable products (commercially available or research prototypes) will be included in a device ecosystem to enable data collection in healthcare and sports use cases. AI technology will be used to develop algorithms for performance, fitness, and health assessment that could be optimized locally at the user-level or scaled up to groups of patients and athletes. Ultimately, domain-dependent professional dashboards and AI-centered applications will be created to generate guidance for health and fitness improvement programs.

Inno4Health

Stimulate continuous monitoring in personal and physical health

Improving how patients prepare for surgery

Improving how athletes prepare for sport competition

Helping professionals manage remotely patients health after hospital discharge and identify risks for adverse events in athletes

E. A broad variety of it companies in cities that each have their own strengths and profiles

The cities of Brabant each have their own profiles when it comes to IT developments. It goes without saying that all the province's cities embrace trends and developments and work on making the economy, government, society, cities, and everything else smarter. But each city has its own emphasis.

Breda - Creative software and game development

In Breda, work is ongoing to make the city smarter and to provide an infrastructure for the business community. Developments such as Breda Robotics, DALI, and the World Class Maintenance Field Labs are all a part of this process. Breda is also creating one or more campuses to boost digitization in a range of areas. What makes Breda unique in the IT landscape of Brabant is the study programs available in Breda University of Applied Sciences in the field of game technology, together with an associated research program. There are also a number of companies that are cutting-edge in the world of IT and creativity, such as CM, Boldly XR, Let's Talk, RB-Media, E-sites, and Imagination Lab. That is why the city created the Breda, City of Imagineers program.

A good combination can also be made with the specialism of GATE2, which lies in the field of simulation, VR and AR.

Tilburg – Machine and human interaction and logistics

Tilburg has the lowest concentration of actual IT companies in the province, but there is still a great deal of IT in the city, even though it is not as visible. Numerous major insurance companies are located in Tilburg, and IT has become an important part of their business. There are various large logistics operations in Tilburg and surrounds, very large-scale logistics warehouses where handling, order picking, and inventory management is increasingly done with the help of complex IT systems. Smart logistics is consequently an important spearhead in Tilburg.

What makes Tilburg unique is the interaction between man and machine. Tilburg University has a number of research programs in this area as well as in the field of AI and ethics, while experimentation also features regularly. Through its many projects, the MindLabs project is studying the interaction between humans and new technologies.

Den Bosch – Business software

Den Bosch has a concentration of IT companies that focus on business-to-business and business software, including the likes of SAP, CTAC, PinkRoccade Healthcare, Epic, Dassault Systèmes, Sogeti, VAA, and Dimensys.

The municipality of Den Bosch is also committed to building an IT community in the city where companies can work together.

Den Bosch is also the seat of the Jheronimus Academy of Data Science (JADS) – a unique partnership between the Province of Brabant, the municipality of Den Bosch, Tilburg University, and Eindhoven University of Technology and a center for education, research, and business in data science.

Eindhoven – Enabling software for high complexity systems

The Eindhoven region is the innovation hotspot of the Netherlands when it comes to complex high-tech systems and machines. This stems from a long history of technology and innovation that started at Philips. Today it is not only Philips but also companies such as ASML, Thermo Fisher, NXP, Signify, and numerous suppliers such as VDL, Gebr, Frencken, KMWE, NTS, Antheryon, Prodrive, Applied Micro Electronics, and others that are operating in the Eindhoven region.

The machines that are built in the Eindhoven region have become increasingly complex, as has the embedded software needed to measure and control the machines. In addition, increasing data streams are generated by these machines. This data can be converted into valuable information for further improving the machines and creating new innovations. Major players in that respect can also be found in the Eindhoven region, such as Altran, Alten, Sioux, Philips Innovation Services, TMC, Kulicke and Soffa, IT Group, The MathWorks, and ABB. Then there are the numerous knowledge institutes, including TNO ESI, Eindhoven University of Technology, and Fontys, all specializing in the field and conducting research projects, together with the many field labs and networks, such as High Tech Software Campus, Data Value Center Smart Industry, and Factory of the Future on the Brainport Industries Campus and AI Innovation Center, Cyber Resilience Center, and the 5G Hub on the High Tech Campus.

In summary, Eindhoven and the surrounding area has an extensive network of companies and knowledge institutes that are engaged in enabling software for complexity systems.

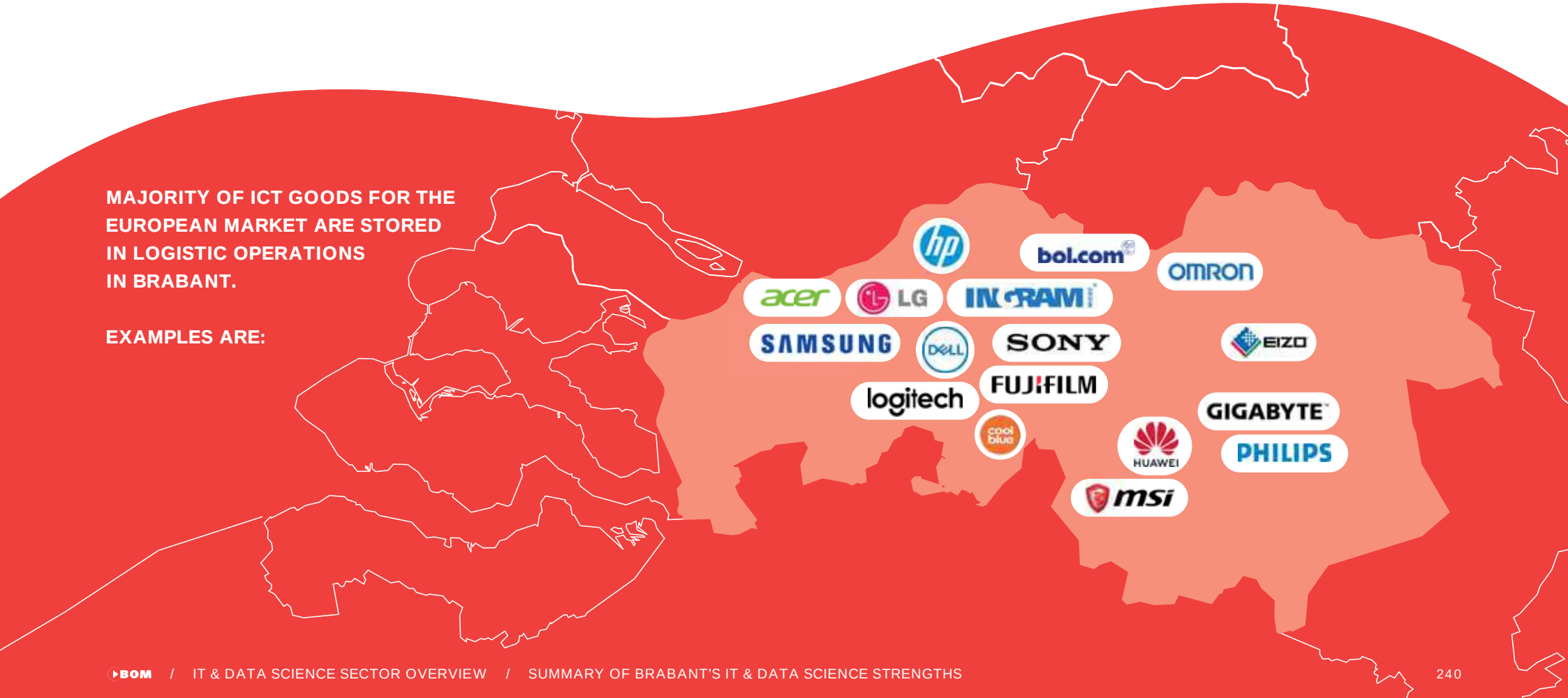
In addition, Eindhoven is also home to a wide variety of other IT companies, such as Atos, Here Global, Mapscape, TomTom, CGI, Exact, Rescop, Itility, and Mirabeau.

F. The Ideal geographic location and perfect steppingstone into Europe

The Netherlands was dubbed the Gateway to Europe decades ago, and nothing has changed since. That is a label that is even more appropriate to Brabant, located midway between the largest ports, airports, and markets in north-western Europe. The ideal location means that most of IT hardware that is distributed to Europe is warehoused in Brabant.

MAJORITY OF ICT GOODS FOR THE EUROPEAN MARKET ARE STORED IN LOGISTIC OPERATIONS IN BRABANT.

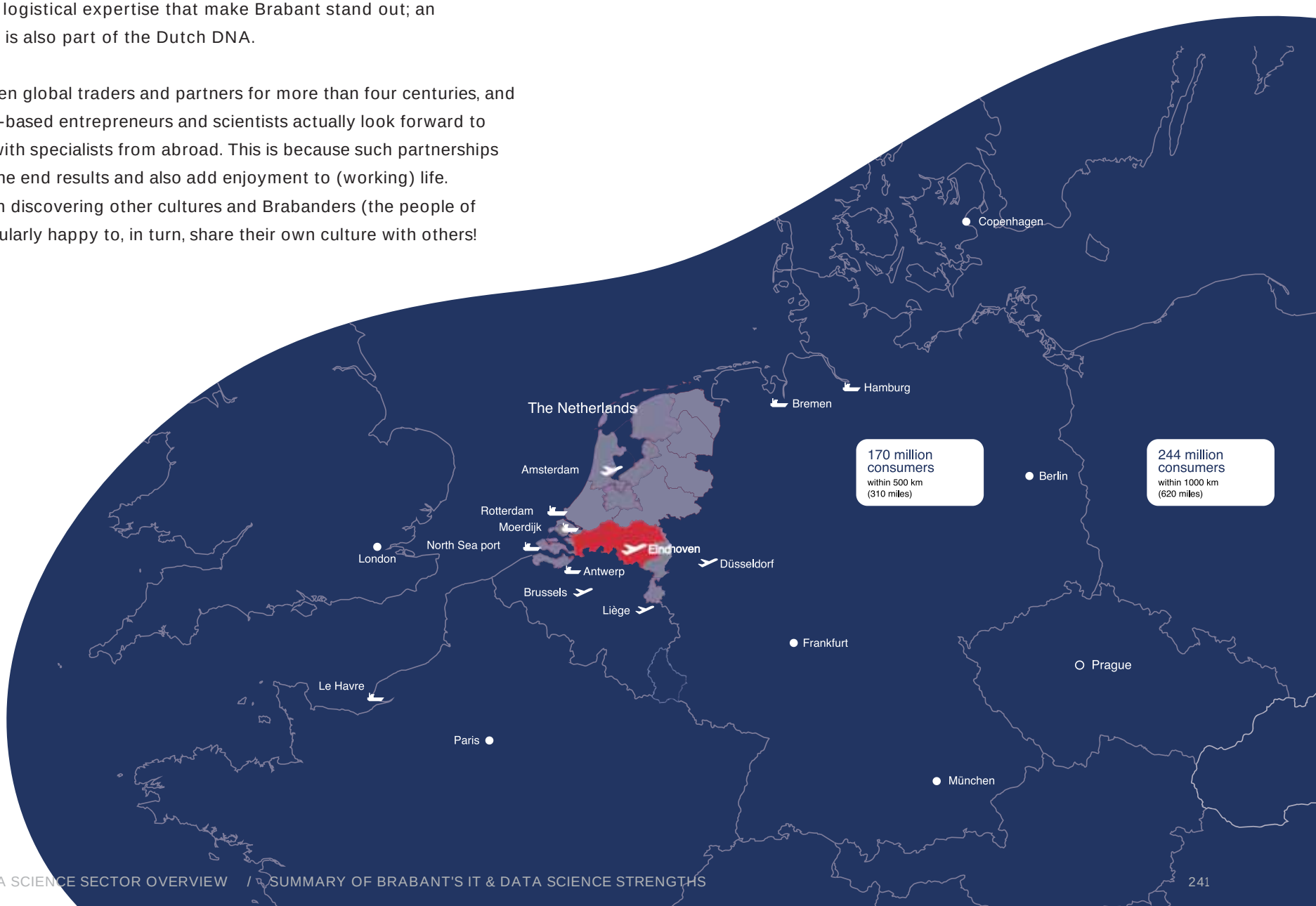
EXAMPLES ARE:



GLOBAL TRADERS

And it is not just its geographic position, the excellent infrastructure and thevast amount of logistical expertise that make Brabant stand out; an international focus is also part of the Dutch DNA.

The Dutch have been global traders and partners for more than four centuries, and Dutch and Brabant-based entrepreneurs and scientists actually look forward to working together with specialists from abroad. This is because such partnerships can only improve the end results and also add enjoyment to (working) life.
The Dutch thrive on discovering other cultures and Brabanders (the people of Brabant) are particularly happy to, in turn, share their own culture with others!



G. Brabant's quality of life is excellent, especially for knowledge workers and expatriate couples or families

The Brabant region offers an almost unique, pleasant, and very safe environment to live in. The Brabant region is a very appealing to Dutch and non-Dutch people alike, and quality of life in general is excellent. Besides the great tech and IT job opportunities in the region, it has a pleasant and dynamic environment, a high-quality education system, excellent transportation, a favorable tax climate, a superb healthcare system, and a thriving international community.

The Netherlands and Brabant are small

Looking at the world map, one can see that the Netherlands is a very small country. The longest distance one can drive from the north to the south is 370 kilometers by car and will take about four hours. To the east, the Netherlands borders Germany, to the south, Belgium, and to the north and west, the Wadden Sea and the North Sea. The Netherlands has 12 provinces, with Brabant one of the larger ones. This immediately gives some perspective with respect to distances in the Netherlands: everything is very close by. To travel from anywhere in Brabant to the metropolitan areas of Amsterdam, The Hague or Rotterdam will never take more than an hour or two at most, whether by train or by car. The same goes for the international airports of Schiphol Amsterdam, Düsseldorf (Germany), and Brussels International Airport. What this adds up to is that Brabant offers a quality of life that is increasingly appealing to knowledge workers and expatriates. The region has a green and friendly environment, with vibrant cities and quiet little villages. Accommodation is also cheaper than in the western part of the Netherlands, while it is fairly easy to find larger homes and ones with gardens, which is not the case in metropolitan areas such as Amsterdam and Rotterdam.

The landscape

One feature of the Dutch and Brabant landscape is unmistakable: the country is extremely flat. There are a few hills in the southeast corner of the country in Limburg, but even these barely infringe on the broad, unbroken expanse of sky that is so characteristic of Dutch landscape painting. Most people coming to the southern Netherlands will probably choose to live in the area near their workplace. However, Dutch infrastructure and transport networks are good and it is easy to commute from other areas to Brabant and its larger cities, such as Breda, Eindhoven, Den Bosch, and Tilburg.

Brabant itself is a wonderful area to live and work in. The landscape is characterized by vast forests, meadows, green pastures, farmland, moors, and waterways. The cities all have historic centers, often dating back more than 700-800 years, but offer modern architecture and residential areas too. The city of Den Bosch, for example, once the capital of the Duchy of Brabant stretching deep into current Belgium, was awarded its city charter and accompanying trading privileges by the Duke of Brabant, Hendrik I, in the year 1196. And so, the living environment in Brabant is varied enough to suit everyone, from an apartment or urban dwelling in one of the vibrant cities to a quiet cottage in a remote village surrounded by greenery. And a night out in Amsterdam without having to book a hotel room is easy.

The housing market is just as varied as the landscape. Not only are there old-fashioned farms and craftsman's houses, but also new construction projects and villas. You can live in the green countryside or near the busy life of the town center. The quality of life in Brabant and in the Eindhoven metropolitan area are often described as "highly livable", which is a huge compliment. To put it into an international perspective, expatriates often compare the region to other cities in the world that are deemed to be very livable, such as Munich, Vancouver, Stockholm, and Zurich.

11. OPPORTUNITIES IN IT & DATA SCIENCE

On the occasion of this in-depth review of Brabant's IT & Data Science sector, the authors have performed a SWOT analysis of the industry. The interviews with the many operational and academic representatives of the industry were of invaluable help in this work.

The analysis has led to the conclusion that six strategic areas can be identified as high potential targets for the activities of the Brabant Development Agency and its partners in the economic development community. This group of six areas has been divided in two categories: the priority niches and the development areas. In the first category, the priority niches, Brabant IT & Data Science companies and clusters are already international market leaders. In the second category, the development areas, the Brabant IT & Data Science sector has already developed such an outstanding business and science platform to build upon that further development in these areas will also raise it to global leader levels.

The priority niches are

- Embedded software for complex high-tech machines
- Smart Health: Big Data & AI solutions in healthcare
- Smart Industry: Big Data & AI solutions in industry

The development areas are

- Smart Mobility: Big Data & AI solutions in Mobility
- Smart Logistics: Big Data & AI solutions in Logistics
- Business and Institution software
- Applied creative software technologies
- Cybersecurity software (development niche)
- Communication software (5G, LoRa, etc.)
- Smart AgriFood: Big Data & AI solutions in AgriFood

A. The priority niches:

1. Priority Niche 1: Embedded Software for complex high-tech machines

USPs for Brabant	Brabant is the leading IT & Data Science province in the Netherlands and famous for a long tradition in creating innovative products and highly complex machines. Hardware and software have gone hand in hand in Brabant for many years, and from that tradition, enormous experience has been gained in complex embedded software development. Today, the region is home to the complete IT & Data Science supply chain. In addition, companies can rely on a top knowledge infrastructure including specialized embedded systems institutes and software companies.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS university of Applied Sciences, Avans University of Applied Sciences, Tilburg University, TNO-ESI, ARTEMIS Industry Association, EIASI (Eindhoven Artificial Intelligence Systems Institute), Cyber-Physical Systems Center Eindhoven
Leading companies/disruptors/best practices	ASML, Philips, NXP, Thermo Fisher, Sioux. Dassault systems, The Mathworks, DVC Machinevision, Process Gold.
Leading cooperative projects/programs	High Tech Software Cluster, Smart industry Hub south, AI Hub Brainport, World Class Maintenance, 5G hub Brainport Eindhoven, ITEA
Field labs	The Factory of the Future field lab, Data Value Center Smart Industry (DVC-SI), Breda Robotics, "Samen"-Together field lab by World Class Maintenance, Capella field lab, CAMPIONE 2 field lab, Flexible Manufacturing field lab, Multi-M3D field lab, Smart connected supplier network, 5G Hub, 5G Manufacturing Industry field lab, field lab at the Brainport Industries Campus (BIC)
Facilities/Locations/Campuses	High-tech Campus, Brainport Industries Campus, AI Innovation Center, BrainBloc, TNO-ESI

INTRODUCTION

Last years, the embedded systems market has evolved considerably. Both technology and industry changed rapidly. With the arrival of industrial IoT (IIoT), embedded systems technology has become an enabler for the world of smart and connected IIoT ecosystems. In the service of machine control, increasingly complex software has been developed that has helped make the next generation of machines possible. What started as simple system control has evolved into deep machine learning and AI.

The ongoing "digital transformation" of the industry, also called the 4th industrial revolution, is rapidly changing embedded software technologies. Nowadays, machines should be able to control each other with new innovative information and communication techniques. One of the major trends in the embedded software industry is the emergence of intelligent edge devices. These edge devices help to enable industrial production systems and plants to become part of the digital enterprise.

Embedded intelligence in sensors will allow data to be accessed, aggregated, and analyzed to power advanced analytics, enabling production systems and equipment to become part of the IIoT ecosystem and digital twins.

However, to support these opportunities, both cloud and edge infrastructure technology providers need to further scale up to support billions of sensors and tens of thousands of smart systems. Rquirement: The edge devices must be both connected and intelligent.
The overall embedded systems market will see significant growth because of the huge demand for intelligence at the edge. The ongoing evolution of IIoT ecosystems and the steady progress of industrial automation to cyber-physical systems based on predictive and prescriptive analytics will eventually lead to autonomous and self-healing systems. In the Netherlands, the Brainport region is the number 1 region when it comes to software for highly complex systems. Years of accumulated knowledge make this a unique strength of the region.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION?

The Brainport region has been at the heart of machine-building in the Netherlands for decades and is a global leader, thanks to companies such as Philips Medical Technology, ASML, and Thermo Fisher. If there is one region in the world where they know how to build software to control a high-tech machine, then it is Brabant. And the exact same principle applies to developing embedded software. The design and development of embedded software requires a fundamental understanding of physics – what is actually going on inside machines - and the technical ability to translate this into software that gets equipment to do what it must do. The complexity of embedded development strategies for high-tech equipment is often huge, for example due to the high demands on robustness and time-critical algorithmics that drive real-time processes and cost-effectiveness in hardware solutions. Optimum solutions therefore require a combination of qualities, such as high degree of competence on the part of individual developers, intensive collaboration within a dedicated team, knowledge of critical high-tech processes, and experience in organizing innovation at the cutting edge of hardware and software. This is exactly what the region of Brabant has developed.

The machine building companies in Brabant have a great deal of knowledge in embedded software available in-house. Examples include ASML's lithography machines, Philips' medical devices, NXP's chips that used for autonomous driving, and Thermo Fisher Scientific's electron microscopes. They all underscore the facts that hardware and software are closely associated in Brainport Eindhoven. But these companies do not have to develop the solutions themselves, and they can also rely on a top knowledge infrastructure that includes institutes like the Eindhoven University of Technology, JADS, TNO-ESI, and software companies like Sioux, Dassault Systems, The Mathworks, DVC Machinevision, and Process Gold.

The Embedded Systems Innovation Center:
Hosted by TNO, ESI is an open and diverse innovation research center with strong partnerships with industry-leading high-tech companies. Through the development of new methods and techniques for system design and engineering, ESI addresses the ever-increasing complexity facing the high-tech industry in the systems it creates. Its extensive research program aims to advance the high-tech industry by improving the lead times and effectiveness of their product innovation processes, as well as the functionality, quality, and societal impact of their products.

Sioux Technologies is a global company specializing in embedded software for high-tech systems. Sioux Technologies has all the expertise it needs in-house to develop and construct complex high-tech products and production systems, often on the edge of what is technologically possible.

Sioux takes the pressure off OEMs in developing high-quality innovative embedded software for the optimal control of hardware features of high-tech equipment, such as precision positioning and optical monitoring. Sioux's strength lies in the unique combination of high-quality competences in software, mechatronics, mathware, electronics, and assembly. With more than 750 engineers aboard, Sioux supports or makes up the R&D departments of leading high-tech companies and groundbreaking startups. Sioux can take over situations from creating ideas in the conceptual phase through to the delivery of serial production. Sioux adds value to its clients and helps them build innovative solutions that can contribute to a society that is smarter, safer, healthier, more enjoyable, and more sustainable.

Advantech Embedded Software provides a wide variety of IoT solutions one requires from IoT devices, from operation management software to cloud platform services that help customers build, manage, and deploy applications on a global network with preferred IoT frameworks, as well as IoT security services, including backup recovery, embedded BIOS, OS, API Library and i ntegrated service platforms on WISE-PaaS Marketplace.

2. Priority Niche 2:
AI in Healthcare: Smart Health

USPs for Brabant	With a rich history of more than 125 years in medical technology development, initiated by Philips, every element of medical technology and advanced healthcare expertise can be found in the region. Brabant is home to a complete network of knowledge institutes, suppliers, and partners in the life sciences and health sector. Developing AI and data science came naturally to Brabant, where high tech and life sciences & health have been natural siblings for many decades. Groundbreaking AI smart health developments are achieved in Brabant, even where AI is still in its infancy. The possibilities are endless and partnerships within the region only boost innovation.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS university of Applied Sciences, Avans University of Applied Sciences, Tilburg University, Holst Centre, EIASI (Eindhoven Artificial Intelligence Systems Institute)
University and other hospitals/universities/research institutes involved	Catharina Hospital; Maxima Medical Center; Kempenhaeghe Epilepsy and Sleep Center
Leading companies/disruptors/best practices	Eindhoven Medical Robots, Philips Medical, GE Healthcare, Teledyne Dalsa, Thermo Fisher Scientific, Bambi Belt, NTS Group, Adimec, Sioux technologies, The Sleep Company, ITEA
Leading cooperative projects/programs	ICAI: e/MTIC Lab, ICAI: MasterMinds Lab, 5G hub Brainport, Brainbloc
Facilities/Locations/Campuses	High Tech Campus Eindhoven; TU/e Campus Eindhoven, Mariënburg Campus Den Bosch, BIC - Brainport Industries Campus

INTRODUCTION

Smart health solutions are intelligent, networked technologies for improved health. Smart health innovations allow healthcare providers to cure afflictions more effectively, to care for patients more efficiently, and to prevent illnesses more frequently. Smart health solutions combine technological developments in mobile and portable devices, mobile data connectivity, application development, sensor technology, and big data analytics and cloud computing with novel ideas on patient co-management, health monitoring for remote communities, and the prevention of unhealthy lifestyles, to name a few. As such, Smart Health has the potential to completely transform the healthcare sector.

AI is one of the main technologies in smart health that is changing the industry. In simple terms, AI is about using large quantities of data to allow machines to take automatic decisions. It is the simulation of human intelligence processes by machines, especially computer systems. AI encoding is based on learning (acquiring data and then creating algorithms to turn them into actionable information), reasoning (choosing the right algorithm to achieve a preferred result), and self-correction (continually adjusting designed algorithms and ensuring that they provide the most accurate results) as three cognitive skills.

AI can help man and machine jointly deliver achievements neither would have been separately capable of. AI is impacting the future of virtually every industry and every human being and, from Apple's virtual assistant SIRI to self-driving cars, artificial intelligence (AI) is progressing rapidly. Artificial intelligence is driving massive improvements and innovation in the healthcare and life sciences industries. It is expediting advances in drug research and discovery and allowing for better and faster diagnoses while also enabling far greater efficiency in business processes. AI is currently being applied to a wide range of healthcare services, including data mining for identifying patterns and then carrying out the more accurate diagnosis and treatment of medical conditions, medical imaging, medication management, drug discovery and robotic surgery.

The challenge in today's healthcare has been formulated very clearly by Sioux Technologies, one of the Eindhoven high-tech companies heavily involved in healthcare technology development: "Because of the rising number of elderly people, we see an increase of chronic diseases and staff shortages. This has profound consequences for the care-lifecycle. Because of increasingly complex technology and digitization, the need for reliability and security of devices and data is also growing. Technological innovation therefore determines the success of OEMs in the medical industry. In addition, it must find its way to the market in a fast and cost-effective manner in the shape of sensible user-friendly products."

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION?

The LS&H sector in Brabant was the subject of a study in 2020 much like this IT & Data Science sector review. It emerged from this LS&H analysis that the region is home to more than 900 companies that employ over 18,000 people.

With Philips (Healthcare) as one of the world's largest medical technology providers, Thermo Fisher Scientific and GE Healthcare Life Sciences Core Imaging and their suppliers on the life sciences and health side, and ASML, NXP, Philips (Research & Innovation), and their full supplier network on the "traditional" high-tech side, the communities met, mingled, and matched and data communication became an integral part of their business models.

Within the Brabant region, more than 500 organizations develop and apply AI solutions. Alongside the companies, the research, knowledge, and educational institutions also prioritize AI. Within the region 20,000 researchers are active, over a thousand of them specialized in AI. Within the Netherlands, most of the AI and data-related patents come from Brabant, and the city of Eindhoven is Europe's most important innovation cluster for data technologies.

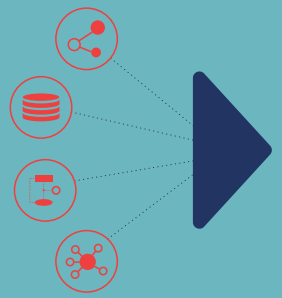
The unique combination of high-quality technical expertise and the traditional thinking in systems enables Brabant to play an important role in new AI solutions and applications in the field of MedTech. Brabant has spent years investing in the development and application of AI and the opportunities in the province are vast. AI is slowly becoming a part of our everyday lives, and it will continue to affect many parts of industry in Brabant in the years to come.

The High Tech Campus Eindhoven is one of those hotspots of open innovation where large and small research companies have been combining their fields of expertise for a long time.

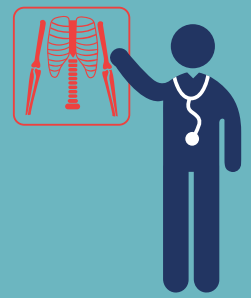
e/MTIC AI-Lab: The e/MTIC AI-Lab is a partnership between Eindhoven University of Technology, Catharina Hospital, Maxima Medical Center, Kempenhaeghe Epilepsy and Sleep Center, and Philips. The main purpose of e/MTIC is to fast-track high-tech health innovations. e/MTIC AI-Lab focuses on improving personalized treatment by having AI work in close collaboration with the clinical staff and MedTech industries, as AI is better able to make reliable decisions in a wide range of healthcare situations. It will play a role in decisions and continuously learn to be a better partner. This requires new approaches, new models, and new benchmarks for the reliability, efficacy, and trustworthiness of AI. The goal of the e/MTIC ICAI lab is to work with a unique mixture of industry, clinical partners, and TU/e researchers to maximize the value of AI for the clinical practice.

International Philips Project: IMPACT:
Global healthcare systems are focused on improving patient outcome and cost efficiency, but do so in the face of growing demand and declining staff capacity. In the United States alone, roughly 1,000 people die every day as a result of preventable medical errors. Meanwhile, inefficiencies cost ¤100 billion per year worldwide. Personalized treatment planning, industrialized treatment and workflow optimization are necessary steps forward, but require a shift from evidence-based to intelligence-based healthcare.

THE FOUR MAIN TOPICS THAT WILL BE ADDRESSED IN THE *IMPACT* PROJECT

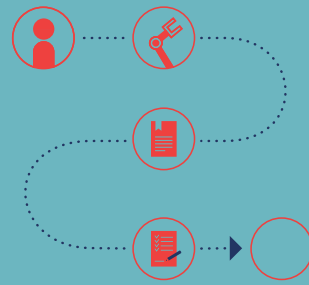


Intelligent data integration and analysis



Personalised treatment planning

Industrialised treatment



Fit to workflow at all hospital levels

IMPACT (Intelligence based iMprovement of Personalized treatment And Clinical workflow support) will promote automatic data collection and artificial intelligence throughout the complete clinical pathway. Building upon previous ITEA projects, various innovations will be developed by a consortium of providers of medical imaging hardware and software, medical display and communications solutions and visualization, integration, and supporting tools. IMPACT's use cases will focus on oncology and cardiology, which suffer from unpredictable patient trajectories and fragmented data repositories. IMPACT will combat this through, for instance, the simultaneous use of multiple imaging features and machine learning analysis of the results, which has been shown to provide more accurate definitions of tumor subtypes. IMPACT's main outcomes can be summarized as follows. For personalized treatment planning, aggregated data repositories will provide an overview of a patient's entire medical record. Smart mechanic devices and image guidance will lead to industrialized treatment, allowing surgeons to perform less invasive surgery. Finally, workflow optimization partners will create real-time intelligent dashboards and data presentation solutions. By leveraging advancements in data intelligence technology, medical workflow robotics, and real-time imaging navigation, the underutilized field of radiomics (converting digital medical images into mineable data) will also be developed.

3. Priority Niche 3:
AI in HTSM: Smart Industry

USPs for Brabant	Brabant already has a well-developed HTSM industry and a world-class high-tech one, including a strong data science community, as demonstrated by JADS, the Jheronimus Academy of Data Science, and EIASI (Eindhoven Artificial Intelligence Systems Institute). The high-tech market leaders and suppliers have a proven capacity to jointly develop, manufacture, and market high-tech systems. The region is home to a unique combination of high-quality technical expertise, traditional systems thinking, and software development for industrial solutions. This combination plays a key role for AI solutions and applications in the field of Smart Industry.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS university of Applied Sciences, Avans University of Applied Sciences, Tilburg University, TNO-ESI, EIASI (Eindhoven Artificial Intelligence Systems Institute)
Leading companies/disruptors/best practices	ASML, Philips Innovation services, NXP, Atos Origin, Dassault Systèmes, Sioux, Prodrive, Advantech, Frencken Mechatronics, VDL ETG, and many more.
Leading cooperative projects/programs	Smart Industry hub South, High Tech Software Cluster, 5G hub Brainport, ICAI: AI-enabled Manufacturing and Maintenance (AIMM) Lab, ICAI: The FAST LAB, ICAI: MasterMinds lab, Platform Driven by data, ITEA
Field labs	Advanced Manufacturing Logistics, Data Value Center Smart Industry, The Factory of the Future (Smart Industry Hub), Flexible Manufacturing, Multi-M3D field lab, Smart connected supplier network, 5G Manufacturing Industry (BIC) field lab, Breda Robotics, CAMPIONE 2 field lab, VIA APPIA World Class Maintenance field lab, "Samen"-Together field lab, Capella field lab, SPARK Industry field lab
Facilities/Locations/Campuses	High Tech Campus; AI Innovation Center, Brainport Industries Campus, TU/e TNO-ESI, Jheronimus Academy Data Engineering (JADE) Lab, DATA Value Center Smart Industry Eindhoven, The Factory of the Future (Smart Industry Hub), Gate2.

INTRODUCTION

The volumes of data generated in these environments are enormous. But what would happen if the machines and processes could gather insights from these high volumes of data by themselves and optimize their processes while operating? The potential would be vast. The good news is that this can already be achieved, step-by-step, using artificial intelligence (AI). **The manufacturing industry is leading the way in the application and adoption of AI technology.**

AI allows us to overcome many internal challenges that exist in the industry: from expertise shortage to complexity in decision-making, issues related to integration, and information overload. Making use of AI in manufacturing plants enables businesses to completely transform their proceedings.

Transporters move through factory halls without a human driver, plants optimize their power consumption during live operation, and machines perform quality-control checks – and make the necessary adjustments automatically – while manufacturing is still in progress... artificial intelligence offers tremendous potential for the industry. It is already making production more efficient, more flexible, and more reliable. The industry is becoming increasingly digitalized, with digitalization turning it into a Smart Industry.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION?

The HTSM industry in Brabant was the subject of a study in 2020, much like this IT & Data Science sector review. It emerged from this HTSM analysis that the region is home to more than 15,000 companies that employ over 129,000 people.

Brabant is home to the entire High-tech Systems & Materials value chain, which not only means the presence of OEMs, research institutes, universities, and vocational schools, but also the whole spectrum of HTSM suppliers in the region. The region is globally renowned for the unique ability to develop and manufacture products and components at low volume and of high-complexity. The province is dedicated to using AI in these systems to advance the industry and increase production through solutions that add value.

To enable innovation, an open approach to research and innovation is used, combined with an excellent infrastructure and a highly-skilled workforce. Companies can find all of these elements on the innovative campuses in the region, such as the High Tech Campus, Brainport Industries Campus, and the TU/e Campus. Examples of AI/smart industry-focused collaborative projects include:

AI-enabled Manufacturing and Maintenance (AIMM) Lab: this is a collaboration between Eindhoven University of Technology (TU/e), KMWE, Lely, Marel, and Nexperia. The Lab's goal is to develop better data science techniques that result in improvements in both manufacturing and maintenance. The AIMM Lab is located at the Eindhoven Artificial Intelligence Systems Institute (EAISI) to promote AI research in cooperation with industry. The areas of research of the AIMM Lab will directly interface with topics such as autonomous agents and robotics, computer vision, decision making, information retrieval, knowledge representation and reasoning, neuro-linguistic programming, and machine learning. As part of the Lab, industry partners and the TU/e will jointly develop research proposals with companies from the region.

ASIMOV - AI training using simulated instruments for machine optimization and verification: With the rise of high-tech cyber-physical systems (CPSs) in all areas of industry and society, the user-friendliness and up-times of these systems has become increasingly important. Keeping the control parameters of CPSs in their correct operating window is a particularly major challenge, such as in electron microscopy, unmanned utility vehicles, and pulp and paper process control. ASIMOV will increase the autonomy and self-optimization of CPSs by creating physically realistic digital twins of these systems and train innovative AI algorithms for CPS control using these digital twins.

B. The development niches

1. Development Niche 1: AI in Mobility: Smart Mobility

USPs for Brabant	The vast majority of automotive companies in the Netherlands are located in Brabant and Limburg, the two adjoining southern provinces. The Brabant region is a global leader in mobility. The breadth and depth of skills and expertise in Brabant is so extensive that it is no exaggeration to say that the Brabant automotive cluster can invent, design, engineer, assemble, manufacture, commercialize, install, and maintain probably any component and/or system related to smart and connected mobility and sustainable or green mobility.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS University of Applied Sciences, Avans University of Applied Sciences, Tilburg University, EIASI (Eindhoven Artificial Intelligence Systems Institute), TNO, IMEC, Holst Center, De Innovatiecentrale
Leading companies/disruptors/best practices	NXP, TASS International, DAF Paccar, VDL Group, Altran, KPN, EIT Smart Mobility, FIER Automotive and Mobility, TNO, ITEA
Leading cooperative projects/programs	ICAI: Mobility Lab, SmartWayz
Field labs	5G Automotive lab, A270 Living Lab
Facilities/Locations/Campuses	Automotive Campus (Helmond); High Tech Campus Eindhoven; TU/e Campus Eindhoven; Eindhoven Artificial Intelligence Systems Institute (EAISI); JADS Campus (Den Bosch); Brainport Industries Campus (BIC, Eindhoven); Aviolanda Aerospace (Hoogerheide)

Smart Mobility is a catch-all term for the use of smart solutions in mobility – developing fully self-driving cars as well as smart roads that maintain contact with the vehicles that use them. Smart Mobility is an intelligent transport and mobility network, where various elements of technology and mobility meet, and a rethinking of the transportation infrastructure used in daily life and business. This not only includes the use of traditional motor vehicles, electric vehicles, and public transportation systems, but also completely new modes of transportation.

- AI in Mobility: self-driving vehicles will undoubtedly be the next big thing. Although they are still in the research and trial stage in many countries, AI-based self-driving will potentially replace manual driving and make driving on roads safer. Research is also underway to leverage AI algorithms to optimize public transport for scheduling and routing, and even traffic light-management.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION?

The Netherlands, and Brabant in particular, plays a pioneering role when it comes to smart mobility. Companies such as DAF-PACCAR, NXP, VDL, and TomTom are leaders in the field.

At the Automotive Campus in Helmond, the OEMs from the regions work together with telecommunications companies to create smart mobility innovations. The community provides what is required to innovate by offering: a high level of knowledge, effective cooperative relationships, and all facilities for virtual and real-life testing.

For example, On the A270 motorway, innovations can be tested in a living lab on the smartest road in the Netherlands. The automotive campus also offers a 5G fieldlab with low latency and an extremely stable internet connection for the development of self-driving cars.

The Campus can be thoroughly researched thanks to the many testing and research facilities available. International companies and public agencies are regularly invited to attend these tests. These tests and hundreds of other activities encourage knowledge sharing, open innovation, and collaboration. And that is why the Campus is so highly regarded internationally in the world of mobility.

SMART PROJECT – TU/E AND CITY OF EINDHOVEN (POTENTIAL END-USER).

The TU/e is working on the spatial modelling analytics and real-time tracking together with ViNotion, the City of Eindhoven, and other national and international partners.

The SMART Mobility ITEA project aims to mitigate traffic congestion and revolutionize transportation within cities. By leveraging 4D spatial technology platforms and real-time vehicle location data, economic and environmental inefficiencies can be reduced and quality of life improved. The same technologies can be used to respond to and recharacterize traffic systems in a post-Covid-19 world.

The SMART (spatial modelling analytics and real-time tracking) Mobility project aims to give city planners and managers the tools needed for decision-making, such as integrated sensors, agile data repositories and automated visualization, simulation, and analysis systems. Six pillars make up the technological framework:

1. An innovative 4D analysis platform
2. Access to real-time vehicle data
3. Sophisticated data modelling tools
4. Connectivity and data exchanges between different stakeholders
5. Detailed traffic flow sensing, followed by data analysis to facilitate smart decisions
6. Traffic control streamlining via precise transporting and mobility

Together, these tools, models and data will deliver enhanced situational awareness of transportation flows, which supports better planning and management, reducing traffic congestion. It will also facilitate faster and easier access to on-demand ride services, ride-sharing, carsharing and bikesharing programs.

2. Development Niche 2: AI in Logistics: Smart Logistics

USPs for Brabant	Brabant is the number one logistics hotspot in Europe and home to global logistic leaders. In addition, the technical knowledge and the strong data science community boost the use of AI in the logistics field. The community is actively working together in several field labs and networks to create innovative Smart Logistics solutions.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS University of Applied Sciences, Avans University of Applied Sciences, Tilburg University, EIASI (Eindhoven Artificial Intelligence Systems Institute)
Leading companies/disruptors/best practices	Vandelande Industries, IngramMicro, Rhenus Logistics, XPO Logistics, Coolblue, DB Schenker, Coca Cola.
Leading cooperative projects/programs	DALI, Augmented & Virtual Reality and Serious Gaming in Logistics, ITEA
Facilities/Locations/Campuses	High Tech Campus AI Innovation Center, TNO-ESI, Jheronimus Academy Data Engineering (JADE) Lab, DATA Value Center Smart Industry Eindhoven, The Factory of the Future (Smart Industry Hub), Automotive Campus, DALI, House of Logistics

The development of AI has revolutionized the field of logistics. The most significant advancements this technology has introduced include warehouse automation, autonomous vehicles, predictive analytics, and smart roads.

AI has many uses in the supply chain and the logistics industry. Companies around the world are implementing this powerful technology into their everyday operations. Artificial intelligence helps speed up and simplify various essential processes, and automating routine tasks that otherwise take a lot of time improves efficiency and accuracy and reduces the probability of human error. This means the implementation of AI in the logistics industry can reduce expenses and increase customer satisfaction.

FINDING SOLUTIONS –
WHAT MAKES BRABANT THE PERFECT LOCATION?

Besides the fact that Brabant is an important industrial province, it also home to a major logistics industry. Due to its favorable location on the major transport routes between the ports of Rotterdam and Antwerp and the German Rhine region, North Brabant has for years offered much potential with respect to logistics. Measured in square meters, almost a third of the large distribution centers that service the Netherlands nationally are situated in Brabant. The region is consistently named as having the busiest logistics hotspots in the Netherlands. The 2019 ranking list names West Brabant as the third most prominent national hotspot, with Tilburg/Waalwijk ranked first. So it is no surprise that such a great deal of knowledge about and expertise in Smart Logistics is available.

The hubs in Brabant are connected by 356 kilometers of railway lines, 22,600 kilometers of roads, almost 500 kilometers of rivers and canals, and no less than 656 kilometers of pipelines, all of which are part of a strategic vision for a safe, smart, and sustainable mobility network in the region. In practice, this means a shift away from road transport towards transport by water, rail, and pipelines.

Brabant aims to bolster its position in this industry through "smart logistics", i.e. by promoting an awareness that logistics is much more than simply moving goods from one location to another. Organizing the flow of goods requires smart planning, smart management, and smart execution. In Brabant, public agencies, knowledge institutes, and commercial parties collaborate to ensure that businesses have access to all modes of transport for shipping or receiving goods.

The goal of Smart Logistics is to ensure that transport is organized both smarter and better. Smart planning, management and implementation make up the common thread here and logistics and mobility data play the leading role, as they must be obtained and shared. Important key players in Brabant include IngramMicro/Bol.com, Coolblue, Tesla, Sony, Vanderlande Industries, Coca Cola, Rhenus Logistics, DB Schenker, DSV, XPO, and Syncreon.

Midpoint Brabant Smart Logistics is working with the Jheronimus Academy of Data Science (JADS) on exploring the opportunities for Big Data in the supply chain. The underlying idea is that digitization in the logistics chain ensures a more efficient and innovative logistics network. There is a lot of Big Data available, but it is still unclear how a company can capitalize on opportunities by using it.

3. Development Niche 3: Business and Institution software

USPs for Brabant	Brabant is home to a number of world-leading software companies for businesses and institutions. These IT companies help businesses, local governments, healthcare institution, and schools with the digitalization of their processes. Several initiatives have been created to help local governments, companies, schools, hospitals, and other institutions digitalize their processes and services.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS University of Applied Sciences, Avans University of Applied Sciences, Tilburg University
Leading companies/disruptors/best practices	ATOS, AXI, SAP, PinkRoccade, CTAC, ISAH Business Solutions, Itteligence, Itilty, CGI, IBM, Sogeti
Leading cooperative projects/programs	Sociale Cohesie (social cohesion) field lab, Sense of Home field lab, MindLabs, Smart Living City Lab, MKB Data Lab, IT Community 's Hertogenbosch
Facilities/Locations/Campuses	High Tech Campus, AI Innovation Center, TNO-ESI, JADS Mariënburg Campus

INTRODUCTION

The digitization of society has skyrocketed, and regular companies, local governments, and institutions are struggling to keep up with all the latest developments. This is especially true for employees and customers who are not involved with IT on a daily basis. That is why it is important to build accessible platforms that help digitize and automate everyday processes. Much attention must go to the interaction between humans and computers, while it must also be understood that an increasing number of companies and organizations will be data-driven and will require assistance to make that leap.

Brabant is home to a number of world-leading software companies in for businesses and institutions. These IT companies help businesses, local governments, healthcare institutions, and schools with the digitalization of their processes.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION

Brabant offers a great infrastructure for business and institution software companies. The larger cities are home to major IT firms such Atos, IBM, SAP, Sogeti, and CGI that help local governments, companies, schools, hospitals, and other institutions to digitalize their processes and services. On top of that, there are government programs that help to make the economy smart and increasingly digital: Smart Industry, Smart Logistics, Smart Services, IT Community ‘s Hertogenbosch, Mindlabs, MKB Data Lab, Breda Robotics, and many more.

In Brabant, JADS was established to provide companies with training, research programs, and projects to prepare Brabant for a data-driven economy.

4. Development Niche 4: Applied Creative Software Technologies

USPs for Brabant	In Brabant, creative software technologies are used in real-life situations by major international companies. Creative software technologies such as AR/VR are developed in Brabant, with Gate2, BUAS and the Eindhoven University of Technology acting as hotspots where VR/AR applications are explored and tested. In addition, the Brabant region is home to the BUAS which is one of the best-ranked international institutes for the videogame industry in the world.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS University of Applied Sciences, Avans University of Applied Sciences, Tilburg University, TNO-ESI.
Leading companies/disruptors/best practices	Prespective (previously Unit-040), VRee, Manus VR, PWXR, Abstraction Games, Boldly XR, Hulan, Grass Valley Nederland, GameHouse Europe, Philips Medical Systems, Thermo Fisher.
Leading cooperative projects/programs	**Gate2:** Load Master Training Center Royal Dutch Airforce, Air Mobility Training Center Royal Dutch Airforce, Rotary Wing training simulator, B3737 Training Simulator, AR/VR application construction & engineering, industrial automation and simulation. **BUAS:** MSP Challenge Simulation Platform, Gaming Horizon, VIBE (Virtual Humans in the Brabant Economy), AR/VR applications for electron microscopy (with Thermo Fisher) **Eindhoven University of Technology:** Eindhoven MedTech Innovation Center (E/MTIC) High Tech Campus: ITEA, 5G Hub
Field labs	VIA APPIA field lab, BUAS cradle Lab
Facilities/Locations/Campuses	High Tech Campus AI Innovation Center, Effenaar Experience Center, Hyperspace Institute (Strijp S), Enversed VR center (Strijp S), Nexxt VR Experience Center.

INTRODUCTION

Concepts like serious gaming, mixed, virtual, extended, augmented reality, gamification, and others are everywhere these days, and they aren't just for fun. More and more games and simulators are used to train, experiment and discover. Brabant has a number of important hotspots where such applications are developed.

The potential applications of VR/AR are great, and from a technical perspective a great deal is also possible. Basically, it is about responding to the changing way of life, where experience becomes more important than possession and focusing on people and their experience, possibly supported by new technologies. Gamification, VR/AR offer endless possibilities in terms of designing, testing and training in a safe environment. The challenge involves finding the right applications - whether for entertainment or for serious applications in industry, healthcare, and defense.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION

Brabant has a number of hotspots where applications in serious gaming, mixed, virtual, extended, augmented reality and gamification are explored. Just a few standout examples are:

- Breda University of Applied Sciences (BUAS) offers world-renowned courses in computer game development. BUAS students are sought-after employees all over the world. BUAS also conducts field research in game technology.

- Gate2 is located near the Royal Dutch Air Force's helicopter base and is a hotspot for VR/AR applications such as airplane and helicopter simulators, a racing car simulator, and VR/AR applications for industry and maintenance.

- Enversed VR Center at the Strijp S campus is Europe’s largest VR center of Europe. It offers VR experiences for groups and individuals, both for fun and serious applications. A similar VR experience center is located at the former Koepelgevangenis (a former prison) in Breda.

- Eindhoven University of Technology is renowned for digital imaging technology, mostly for medical technology applications, and is also home to the Eindhoven MedTech Innovation Center (e/MTIC) where VR/AR applications for hospitals and health centers and other applications are tested and studied.

AUGMENTED REALITY TO THE RESCUE DURING THE CORONAVIRUS PANDEMIC

01/05 by Brittney Wolff Zatezalo, may 6, 2020

Travel restrictions due to the coronavirus (COVID-19) pandemic mean that some of our customer support engineers can't visit our chipmaker customers' sites to help them keep their lithography machines up and running. During a crisis that could have cost ASML millions or even billions, a cross-functional team used gaming-inspired augmented reality to turn a potential problem into a new opportunity to help our customers remotely.
Within a matter of days following the travel ban from Europe to the US, a joint task force of more than 100 ASML experts mobilized from their homes around the world.

Their mission: Make sure that our multi-million-dollar, state-of-the-art chipmaking equipment stays running at customers' sites in the midst of a global pandemic. The team quickly developed an augmented reality (AR) solution, enabling subject matter experts to 'enter' the cleanrooms in customer fabs (factories) to complete service actions and troubleshoot other issues.

"The silos quickly disappeared," says Peter Peusens, head of Customer Support DUV Operations and project lead of the augmented reality task force. "It was merely a matter of managing the enthusiasm of everyone to walk in the same direction."

Every 24 hours yielded substantial progress, as sub-teams met daily within Microsoft Teams to discuss accomplishments and new tasks to be tackled within a day. After quick factory testing at ASML Wilton and Veldhoven, the Netherlands, the team successfully utilized AR on a smartphone as well as a Microsoft HoloLens headset to complete a full service action on March 20 at a customer's site.

More about the project:
https://www.asml.com/en/news/stories/2020/augmented-reality-to-the-rescue-coronavirus

5. Development Niche 5: Cybersecurity Software

USPs for Brabant	Brabant recognizes the importance of Cybersecurity. Companies in the high-tech manufacturing industry have joined forces to protect their systems and IP. Work is also being done on the security of IT systems in other areas.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, BUAS University of Applied Sciences, Avans University of Applied Sciences, Tilburg University.
Leading companies/disruptors/best practices	Atos Nederland, Thales (Gemalto), Sogeti, Forescout (SecurityMatters B.V.), QNP, Inside Secure, TWC, Orcavoice, Smile, Network Innovations, Profi-Sec Group, Compumatica Several smaller SMEs: RockSecure Cybersecurity, Secuenzo IT Security, Nuvias, Secura, Asomis IT security, Schippers IT, INTRINSIC ID
Leading programs	Cyber Resilience Center Eindhoven, **JADS:** Research Program Data & Crime, **Eindhoven University:** Ei/Ψ Eindhoven Institute for the Protection of Systems and Information (EIPSI), Research groups TU/e**:** Coding theory and cryptology (C&C), Research Labs TU/e: BlackHat's lab, Security Operation Center Lab (SOC) **Fontys University of applied sciences:** Professorship Cyber-physical systems, ITEA
Facilities/Locations/Campuses	High Tech Campus, TU/e Campus - Eindhoven Institute for the Protection of Systems and Information (TU/e), BrainBloC (Twinning by Twice)

INTRODUCTION

The digitization of society is moving at a rapid pace and offers many new opportunities. The world is also becoming increasingly digitally intertwined and connected. But cybercrime is also growing, as the digital world develops. While in the 1980s and 1990s they were still harmless viruses, everyone now has to deal with phishing, spoofing, ransomware, and all the rest. Entire organizations are digitally kidnapped and held to ransom. In addition, foreign powers and criminal organizations are digitally infiltrating vulnerable networks of defense, government, and health organizations or attempting to steal valuable intellectual property from companies. Resilience to digital terrorism has consequently become crucial.

THE CHALLENGE

The challenge is clear: making governments, institutions, and companies digitally resilient and protecting their networks. In practice, this is not that simple, as people and human behavior are often the weak links.
The Dutch government has created the Digital Trust Center (DTC), with the purpose of making 1.8 million Dutch companies more resilient to increasing cyberthreats – everyone from freelancers to large companies that fall under the non-vital industries. Vital industries, such as banks, telecom, energy, and water companies, fall under the National Cybersecurity Center (NCSC).

DTC improves cybercrime resilience using the following steps:
Knowledge, information, and advice: The website offers low-threshold knowledge, information, and advice that businesses can apply.

Developing tools: for many businesses it is difficult to estimate the state of the digital security of the company. The DTC has developed the Basic Cyber resilience scan, which can be used by a company to test its cyber resilience. The scan returns results based on the five basic principles of a secure digital business.

Encouraging cooperation: Cooperation is essential for a company to become more resilient to cyberthreats. The DTC encourages partnerships between companies that assist in creating secure digital entrepreneurship. These cyber resilience networks can work together in a chain, region, or industry, and a €1,000,000 per year was set aside for this purpose in 2018, 2019, and 2020 (maximum of €200,000 per project).

Making the Digital Trust Community available: The online Digital Trust Community offers affiliated companies the opportunity to exchange current and relevant information in a closed environment. The DTC will also distribute current threat information from the NCSC via this channel. The community is currently under development and will be launched very soon.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION

Cybercrime and cybersecurity are developing fields, but they require a company's full attention and should be equal to, if not take precedence over, IT developments.
Several initiatives are in place in Brabant for improving cybersecurity.

The high-tech industry in the Brainport region has launched **the Cyber Resilience Center Brainport** in order to protect IT networks and valuable IP. JADS has started a research program on **Data science and crime** that focuses on the use of data in crime prevention and security.

At Eindhoven University of Technology there are numerous research groups that focus on cybersecurity, including **Ei/Ψ (Eindhoven Institute for the Protection of Systems and Information (EIPSI)**), which is a TU/e research institute covering the entire technical spectrum of information security and with special focus on methods and techniques to protect digital information against unintended effects and interference and the study and design of more complex applications in which security goals like confidentiality, integrity, authenticity, reliability, and availability of data play a crucial role. Another is **Coding Theory and Cryptology (C&C)**, which focuses on the mathematical theory of encoding information in such a way that it becomes resistant to transmission errors, and the mathematical theory of protecting information against unauthorized access (privacy), determining if a message has been altered by a third party (integrity), adding a signature to an electronic document, and verifying the identity.

Cyber physical systems is another field of expertise that is explored in Brabant. The Cyber-Physical Systems Center Eindhoven is located at the Eindhoven University of Technology, while the Fontys Center of Expertise HTSM has a professorial post for Cyber Physical Systems. Cyber-physical system security is becoming crucial, and both groups conduct research into software that is used in a wide range of equipment and machines. Current research is focused on E-grids, E-mobility, and High-Tech Systems.

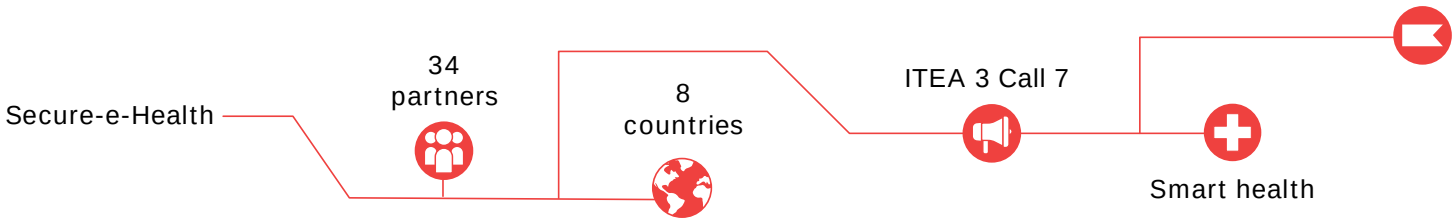
CYBER RESILIENCE CENTER, BRAINPORT

Brainport is the first economic area in the Netherlands with a Cyber Resilience Center. It has been helping companies in the knowledge industry since September 2019 to develop resilience against digital espionage and cyberattacks.
This makes the Eindhoven high-tech region a leader in the Netherlands, where cyber resilience is taken very seriously, over and above the industries designated as vital by the authorities (such as healthcare, energy, ports, etc.). The Center allows companies to be part of a collective, professional system fighting against online attacks.
Participants can exchange confidential information via a well-secured, private platform on threats as well as solutions. The high-tech and manufacturing industry consists of a chain of companies. This highly interwoven ecosystem is only safe to the degree that all players are resilient to cybercrime. Nearly 25 companies from the high-tech industry were founder members of the Brainport Cyber Resilience Center.

Source: https://cwbrainport.nl/en/

SECUR-E-HEALTH

Privacy-preserving cross-organizational data analysis in the healthcare industry: sensitive health data is often kept in silos in a way that cannot be efficiently leveraged for legitimate medical, research, and data analysis purposes. The goal of the Secur-e-Health project is to integrate new approaches for digital ID technologies and privacy-preserving analysis techniques in a secure system infrastructure. The Secur-e-Health system allows medical institutions of all types to work together and leverage data analyses and insights. This is expected to have a significant impact on the quality of the predictive medical models, the efficiency of data-driven treatments, the acceleration of new clinical research, and the improvement of healthcare in general.



Brabant Organizations: TU/e and TNO

6. Development Niche 6: AI in AgriFood: Smart AgriFood

USPs for Brabant	The AgriFood sector in Brabant is getting smarter thanks to the unique collaboration between AgriFood companies and high-tech organizations. High tech and AgriFood are the two principal economic mainstays of Brabant and are capable of competing at international level. Tech companies join forces with AgriFood companies to create smart farming solutions. The AgriFood sector in Brabant has decided to invest heavily in sustainability, innovation, and quality.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science, HAS University of Applied Sciences, BUAS University of Applied Sciences, Avans University of Applied Sciences, Tilburg University, EIASI (Eindhoven Artificial Intelligence Systems Institute), DataLab Agrifood, Holst Centre, TNO, IMEC
Leading companies/disruptors/best practices	Philips Research/Healthcare; Signify (GrowWise); PlantLab; NXP; Dacom; Van den Borne Aardappelen; Royal Cosun/Cosun Beet Company; Aris Vision; Hendrix Genetics; MSD Animal Health; VION; Marel Poultry
Leading cooperative projects/programs	Breed4Food (WUR, Hendrix Genetics, Cobb-Vantress, Topigs, CRV); Eindhoven Artificial Intelligence Systems Institute (EAISI), National Experimental Garden for Precision farming, Campus Almkerk
Facilities/Locations/Campuses	High Tech Campus Eindhoven; TU/e Campus Eindhoven; Eindhoven Artificial Intelligence Systems Institute (EAISI); DataLab AgriFood (Den Bosch); JADS Campus (Den Bosch); Precision Agriculture Center South (Reusel); PlantLab (Den Bosch); GrowWise Research Center by Signify (Eindhoven); Cosun Innovation Center/GPEC, Green Protein Center of Excellence (Dinteloord)

The agriculture and food industries are one of the most vital fields for our survival. Due to several challenges in the future for the agriculture and food sector and various factors, such as climate change, population growth, technological progress, and the state of natural resources (water, etc.), it has become a matter of urgency that digital technologies such as AI be deployed at different stages of the agricultural supply chain.

The intelligence, efficiency, sustainability, and performance of the AgriFood sector can be radically enhanced by using AI.

- **AI in AgriFood:** AI technologies to help yield healthier crops, control pests, monitor soil and growing conditions, organize data for farmers, help with workload, and improve a wide range of agriculture-related tasks throughout the food supply chain. Armed with the data, methods are being developed to grow perfect crops.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION?

Brabant already has a well-developed AgriFood sector and a world-class high-tech industry, including a strong data science community. Future work will aim to further integrate these two related fields of excellence. This is necessary because, firstly, some of the solutions for feeding the world in a sustainable, safe, and healthy manner will be found at the point where AgriFood meets high tech and, secondly, because combining these strengths will further increase the global competitiveness of both industries in Brabant.

Because of its inherent strengths in all relevant AgriFood value chains, Brabant can act as the frontrunner for developing solutions to these challenges and introducing the concepts/products and processes and expertise to the world at large. It has the expertise, the locations, the worldwide contacts, and the disruptors required to challenge the establishment. This corresponds well with Brabant's ambition of making the region the capital for pilot projects, upscaling, and the full-scale implementation of new advances in AgriFood in the Netherlands.

The AgriFood sector in Brabant was the subject of a study in 2020, much like this IT & Data Science sector review. It emerged from this AgriFood analysis that the region is home to more than 13,000 companies that employ more than 81,000 people.

Brabant is the Dutch "locomotive" for new AgriFood industries, with technologies such as sensor technology, vision technology, quality control, data science, farmbots, drones, and many more, all being used for purposes such as precision farming testing at the Precision Farming South experimental center, benefitting all its partners in agriculture, industry, and academia alike.
The further integration of the data science, Big Data, and artificial intelligence component of Brabant's high-tech industry in AgriFood is already taking place through multiple projects and programs in Brabant:

Data communication and data processing in a single link of the value chain, such as:

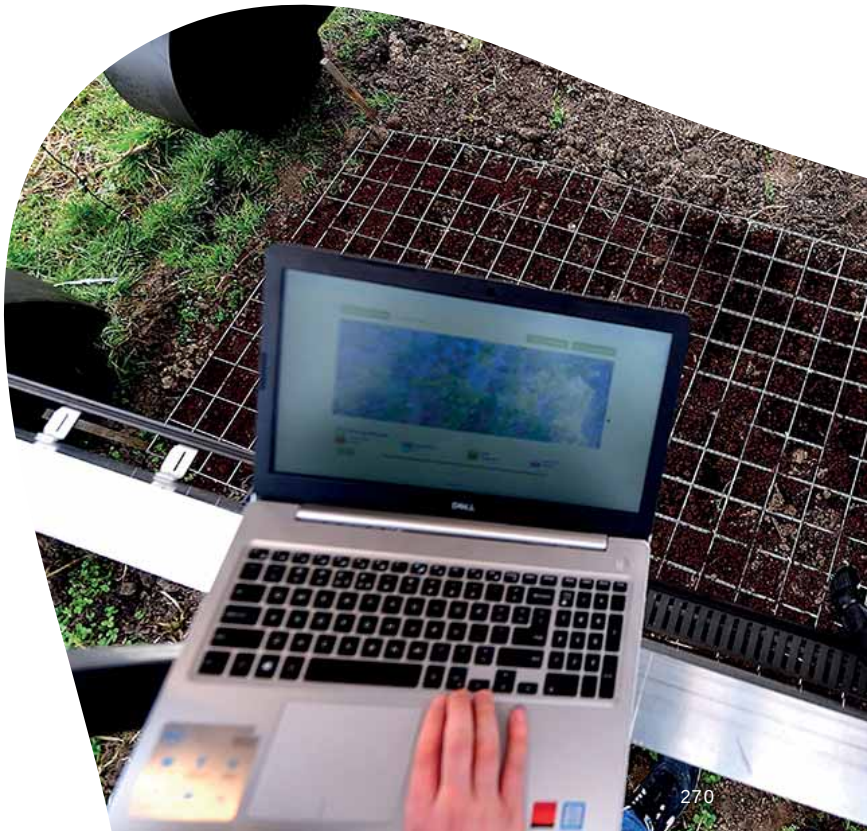
- The data component in the precision farming pilot projects at the Precision Ag Center South, involving companies such as Van den Borne Aardappelen (potatoes), Dacom (sensor equipment and data-driven software), Aris (vision systems), Aerialtronics (AgriFood solutions-developer using drones, AI, and IoT data), and institutes such as TU/e, Delphy, VITO, and TNO
- The data component for the pixel farming concept at Campus Almkerk

Data communication and data processing throughout the entire value chain, such as:

- "The Smart Pig Chain" project: bolstering the pig value chain using data and smart technologies, together with partners such as HAS, JADS, Hendrix Genetics, Agrifirm, MSD Animal Health, VION, and others. In this project the feed value chain and the pig value chain work together to apply technologies for precision breeding, monitoring, feeding, animal welfare, and data integration. In the next phase, retail outlets and supermarkets will also be integrated in the chain in order to coordinate expected market demand peaks (for example, when public holidays fall on days when the weather is good, the demand for meat for barbecues rises) with pork processing levels
- Use of Big Data in the poultry value chain (Hendrix Genetics, VION, Van Rooi, and others)
- The data component is crucial for optimizing plant cultivation yields in greenhouses and indoor farming, and so one of Signify's priorities is the further development of their Yield Rolling Forecast data system

Data communication and data processing partnerships between value chains in different industries

- The data component in all food sector-related matters involving food safety and tracking and tracing (Danone/Nutricia, FrieslandCampina, Cosun Beet Company, Mars, Cargill, Heineken, Bavaria, Unilever, etc.), with a high level of support from dedicated IT companies (such as AppsforAgri and AgriSim), sensor developers (such CowManager SensOor), manufacturers of monitoring systems (Nedap), and many others.



7. Development Niche 7: Communication Software (5G, LoRa, etc.)

USPs for Brabant	Companies, startups, public agencies, and students are joining forces to put the new 5G technology into practice. The Brabant region is dedicated to using the power of 5G in several areas, such as healthcare, the automotive industry, and manufacturing. Several living and field labs can be found in the region for the purposes of innovation and testing these 5G solutions. The region is also home to the Eindhoven Fiber Exchange and a high level of broadband penetration.
Universities and research institutes involved	Eindhoven University of Technology, JADS: Jheronimus Academy of Data Science, Fontys University of Applied Science
Leading companies/disruptors/best practices	Ericsson, KPN, VodafoneZiggo Thales (Gemalto BV), Network Innovations, INTO Telecom & IT, IP Visie Telecom Solutions, Signet
Leading programs	5G HUB BRAINPORT EINDHOVEN, The Things Network, ITEA
Facilities/Locations/Campuses	High Tech Campus AI Innovation Center and 5G Hub, TNO-ESI, Automotive Campus: 5G Automotive field lab, 5G Industrial Manufacturing field lab, Brainport Industries Campus LoRa: The Things Network Breda, Steenbergen, Roosendaal, Eindhoven, Tilburg, Baarle-Nassau, Oisterwijk, Den Bosch, Uden, Helmond

INTRODUCTION

The world is becoming increasingly connected – not just communication between people, but also between people and machines and between machines. In addition, there has been an enormous growth in sensors that receive and send data and that enable smart digital applications, smart devices, smart cities, smart industry, smart services, smart roads, etc. But good infrastructure is essential for transferring and transporting this data, and a modern IT infrastructure is indispensable.

The Netherlands, including Brabant, has one of the highest broadband penetration levels in the world, with near-ubiquitous 4G coverage. But that will not be enough to facilitate all aims when it comes to a smart and digital society, and much more must be done to roll out the 5G network. Moreover, many companies, institutions, and homes still need to be connected to fiber optics networks or other forms of superfast internet.
A LoRaWan network is also required for IoT applications, which works over longer distances and consumes much less energy than the high-frequency 5G networks.

FINDING SOLUTIONS – WHAT MAKES BRABANT THE PERFECT LOCATION

KPN, Ericsson, and VodafoneZiggo are present and active in Brabant. These major telecommunication companies play an important role in the construction of various communication networks in Brabant and the rollout of 5G. They have also joined forces and are working together in the 5G Automotive field lab (KPN/Ericsson) on the Automotive Campus, the 5G Hub (VodafoneZiggo/Ericsson) on the High Tech Campus, and the 5G Manufacturing Industry Field Lab (KPN) on the Brainport industries Campus.

There are also numerous initiatives to equip business parks, residential areas, and the rural areas of Brabant with fiber optics. In this context it is important to note that a fiber exchange is located in Eindhoven.

In addition, there are initiatives to develop a LoRaWan network in Brabant. The Things Network already has communities in Breda, Steenbergen, Roosendaal, Tilburg, Baarle-Nassau, Oisterwijk, Den Bosch, Uden, Eindhoven, and Helmond.

BRABANT DEVELOPMENT AGENCY (BOM):
READY TO CONNECT YOU!

Based in Tilburg, BOM Foreign Investments & International Trade is part of the Brabant Development Agency (BOM). Our BOM Foreign Investments team assists new and existing foreign companies to make optimal use of the opportunities offered by Brabant as a business location. We can offer you our support when it comes to finding sites or real estate, building and environmental permits, labor market analysis, talent acquisition, matchmaking for logistics, employment regulations, fact-finding missions, incentives, and relevant networks in the regional private and public sector.

Our BOM International Trade specialists provide hands-on support to companies in Brabant in growing their business abroad. We offer valuable contacts in foreign countries and provide targeted information on markets and available funding. Our international trade specialists also promote the successful economy of Brabant and its thriving ecosystems to foreign companies around the world.

We offer a range of free services and support designed to provide you with the information and network you need to explore new (business) opportunities.

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