GRIDS GRAND INITIATIVE DATA SCIENCE

Grand Initiative
Data Science
Final report

August 2015

The subsequent work product was written by Deloitte Consulting based on a request from the Grand Initiative Data Science Steering Committee. Deloitte's involvement has been supervised and managed throughout by the Province of North-Brabant. The Steering Committee is comprised of the following members:

- **L.W.L. Pauli** (Regional Minister for Economic and International Affairs, Province of North-Brabant)
- **Drs. H.J.A. Van Merrienboer** (Regional Minister for Financial Affairs, Province of North Brabant)
- **Mr. dr. A.G.J.M. Rombouts** (Mayor, City of 's-Hertogenbosch)
- **E.H.P. Logister** (City of 's-Hertogenbosch)
- **Prof. dr. E.H.L. Aarts** (Rector, Tilburg University)
- **Dr. K.M. Becking** (President Executive Board, Tilburg University)
- **Prof. dr. ir. F.P.T. Baaijens** (Rector, Eindhoven University of Technology)
- **Ir. J.H.J. Mengelers** (Eindhoven University of Technology)

The work product was created in close collaboration with the four GRIDS stakeholders – city of 's-Hertogenbosch, Province of North-Brabant, Eindhoven University of Technology and Tilburg University to meet their request to provide a vision and grand design for the graduate school along with the surrounding ecosystem.

While this work product leverages some Deloitte intellectual property, the intellectual property is shared by the above stakeholders.

Deloitte Consulting BV
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Purpose of this report

The purpose of this report is to expand on the efforts to establish a graduate school and ecosystem in data science by four stakeholders in the North-Brabant region. Each is leveraging their strengths to create a collaborative education and research program in data science that is embedded in a self-propelling ecosystem. The province of North-Brabant, the city of 's-Hertogenbosch, Eindhoven University of Technology (TU/e) and Tilburg University (TiU) have joined forces in an initiative called the Grand Initiative Data Science – (GRIDS). In addition, the stakeholders are working together to establish the Graduate School Data Science Mariënburg. GRIDS represents an overarching, collaborative initiative between the stakeholders, while the Graduate School Data Science Mariënburg is a component of this effort that will complement the existing Data Science Center – Eindhoven (DSC/e) and Data Science Center – Tilburg (DSCt).

Why a Graduate School for Data Entrepreneurship?

The rise of the data-driven society: Data production in both, business and societal settings, has been increasing at a high rate for years. In medicine alone, the amount of data that must be stored, available and understood *doubles* every five years. (Gartner, 2014) The Big Data Value Association indicates that there are €3,3 billion (B) in new European sales opportunities as a result of data science. (Big Data Value Assocation, 2015) In 2015, the amount of wireless Internet of Things (IoT) devices will increase by 60% leading to an installed base of 2.8 B devices. (Deloitte, 2015) All of these devices create massive amounts of structured and unstructured data. To derive value, there is a need for talent that can understand the data, distill insights and convey its impact on business and society.

An unmet demand for data scientists: The massive amount of data created daily creates opportunities for organizations and individuals who can manage the data, understand the data, refine it and convey its impact. This has given way to the data scientist. At the moment, demand for data scientists is currently not matched by the supply. McKinsey estimates that by 2018, in the United States alone, the demand for deep analytical talent could exceed the supply by between 140.000 – 190.000 positions. According to the research conducted by Dialogic, the number of vacancies in the Netherlands for data scientists nearly doubled between 2014 and 2015, a trend that is expected to continue. (Dialogic, 2015)

Triple Helix commitment to address the issue: In North-Brabant, several players have recognized this challenge. The universities, the province and the city of 's-Hertogenbosch have taken the initiative to be an early-mover and form a strong cluster around data science. Other stakeholders (both in the public and private sector) have endorsed the initiative – clear evidence of strong Triple Helix commitment. With these combined resources, the initiative is designed to meet the need for data scientists and as a result, stakeholders will benefit from the opportunities created by a strong data science cluster.

Strong competencies in the knowledge infrastructure: Strong data science or adjacent capabilities exist within North-Brabant's knowledge infrastructure. TU/e has a background in technical sciences and an existing data science center (DSC/e); TiU's has an understanding of business and society as well as its own data science center (DSCt). These competencies combined with the entrepreneurial focus in 's-Hertogenbosch create a complete initiative.

Window of opportunity and first-mover advantage: Society, business, government and knowledge infrastructure are all grappling with data science; GRIDS can take advantage if it acts. Evidence suggests that the window of opportunity continues is closing. The cost of launching an internet technology startup has plummeted 1.000-fold over the past 15 years. (Singularity University, 2015) The lower barriers to entry associated with data science along with its relative lack of capital intensity

(compared to other emerging technologies), hold the potential to make it a new economic pillar for North-Brabant.

Magnet for human capital and companies: A graduate school in data science creates a mechanism for North-Brabant to attract and develop human capital as well as attract and retain large companies. Companies like Philips, who in May 2015 announced it would enter a research alliance with MIT. Philips chose the location (Boston area) based on its concentration of start-ups and research labs and for its proximity to the research projects supported by the alliance. (MIT, 2015) The GRIDS focuses on business and societal relevance creates the opportunity to build similar alliances to benefit North-Brabant.

's-Hertogenbosch as a unique location: The inclusion of 's-Hertogenbosch provides a chance for GRIDS to stand out from its peers by cleverly combining the old and the new. The historic location coupled with reputable data science initiatives at TU/e and TiU create a strong proposition. Its focus on entrepreneurship provides an added dimension that is attractive to new students. (Dialogic, 2015) It also complements competencies in engineering and business & society at TU/e and TiU respectively. The existing Information and Communication Technology (ICT) community in 's-Hertogenbosch is also a selling point, as it has a large presence of small and large IT companies (SAP, Siemens, Quintiq, etc.). The location will provide a springboard beyond North-Brabant, because the proximity to Utrecht, Amsterdam and Schiphol international airport make it more accessible for internationally-oriented businesses and students. Finally, the Graduate School Data Science Mariënburg will be central to everything. It will be centrally-located in the city of 's-Hertogenbosch and become a centralized location for the housing of student as well as start-ups.

Brabant as an innovative environment: Societal challenges including the labor market, circular economy, and sustainable agriculture, pollution, smart transportation, demographic trends and environmental issues are all on the North-Brabant agenda. (Provincie Noord-Brabant, 2015) As one of the most innovative regions in Europe (Eurostat, 2012), this initiative addresses some challenges by attracting and developing talent while creating solutions to societal issues. In data science, GRID will create a middle layer linking the public sector and societal innovation, promoting collaborative risk-taking between companies and knowledge institutes. This connected knowledge infrastructure will be the foundation for North-Brabant's future, creating a new economic pillar while reinforcing existing strengths and industries. Finally, the Graduate School Data Science Mariënburg will be central to everything. It will be centrally-located in the city of 's-Hertogenbosch and become a centralized location for the housing of student as well as start-ups.

What is the proposition?

Collaborative investment: Four parties have come together to invest in the GRIDS. The city of 's-Hertogenbosch, province of North-Brabant, TU/e and TiU have each agreed to invest €10 million (M) each, € 40 M in total, to establish the Graduate School Data Science Mariënburg. This successful Triple Helix (research, industry and government) collaboration is designed to seize the opportunity.

Graduate School Data Science Mariënburg: The graduate school will be a front-office for the GRIDS in North-Brabant. The location in Mariënburg combines the history of the monastery with an exciting vision for data science. It will educate students in an innovative fashion, educating 'T-Shaped' data scientists and researchers (data scientists who have a strong basis in one discipline with knowledge of others), while developing unique valorization services for the surrounding ecosystem.

Education: The educational offerings of GRIDS will include:

- Combined Bachelor's program – TU/e and TiU
- Joint MSc Data Science & Entrepreneurship – Graduate School Data Science Mariënburg
- MSc Data Science & Business and Society – TiU
- MSc Data Science Engineering – TU/e
- Professional Doctorate in Engineering (PDEng)[1]
- PhD program at each location depending on focus (business & society, engineering, entrepreneurship)

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[1] The PDEng will focus on applied techniques and design a professional context working closely together with industry, offering graduates the opportunity to participate in large-scale, interdisciplinary projects.

Research: GRIDS provides researchers with the opportunity for a different type of research program enhancing the relevance of academic research to business and society. The Grand Design aligns with the current regional knowledge infrastructure, creating a new hub in 's-Hertogenbosch that augments the existing schools in Eindhoven and Tilburg. Seven specialized themes link to the industrial and societal strengths of North-Brabant adding relevance via research and valorization services. These include:

1. *Bionic brains and amplified intelligence* – the application of Data Science has the potential to partially or fully automate previously unaffected knowledge activities
2. *The connected wellbeing journey* - leveraging data science techniques to enable personalized wellbeing, an active and healthy lifestyle through the quantified self
3. *Data analytics of things* - related to the Internet of Things, connected devices will generate large amounts of data, and thus data analytics will drive smart industry, smart mobility and smart logistics
4. *Feeding the planet using data* - linked to data science challenges in the field of agriculture, food, nutrition, water and sustainability
5. *Data quest for the customer journey* - data is offering new ways to create value and enhance the consumer experience. Technology and data are being used to empower consumers and instill confidence in purchases, while social analytics are used to monitor and predict consumer behavior
6. *Connecting the modern city* - enables adaptive support and understanding of urban areas through connecting and understanding infrastructure more effectively, as well as engaging citizens more actively
7. *Monetization of data* – the application of data science to traditional industries causes disruption (e.g. Airbnb), capitalizing on new opportunities and new markets fuels exponential growth of new businesses

Extending existing ecosystems: This initiative can build on the proven and effective, collaborative ecosystem in the region. One case is the partnership between TU/e and 20 of its PhDs with Philips via 'living labs' (a user centered, open innovation ecosystem integrating research and innovation processes) to create new data-driven business models. (Flaman, 2015) Beyond these 'Flagship' partnership arrangements, the initiative will offer a range of partnership models reflective varying levels of commitment and size. So more basic models will be available for Small, Medium Enterprises (SMEs).

Valorization benefits: Through GRIDS, North-Brabant can also realize a range of valorization benefits for the ecosystem, including:

- *Increase in data science labor availability:* in a steady-state, the GRIDS will produce about 1.500 data scientists a year at various levels (BSc, MSc)
- *New business models:* business and organizations are increasingly enabled by deeply integrating data into their business model. GRIDS – and especially Graduate School Data Science Mariënburg – will develop students with the requisite knowledge
- *Innovative projects:* Similar to the Philips Flagship project, the GRIDS initiative will provide the opportunity to participate in innovative research projects
- *More opportunities for European R&D financing:* The educational and research opportunities in the GRIDS initiative are eligible for EU funding (e.g. Horizon 2020, Erasmus, etc.)

In the future, these benefits could occur through additional offerings.

- *Spin-off opportunities:* The knowledge valorization organization can provide an opportunity for new data science technologies and early-stage companies. Eventually, companies could be spun-off to generate revenue
- *Improved ecosystem services:* The initiative could provide data science related services to SMEs in 's-Hertogenbosch and the wider North-Brabant region

Building a data science ecosystem

In the seven underlying themes, the GRIDS will apply data science to business and organizational challenges. In many of these areas, there is already clear market potential for GRIDS. Based on Deloitte analysis (additional details can be found in Appendix: Onboarding Funnel), the initial addressable market – the revenue opportunity for GRIDS research, products and services – at North-Brabant based companies is estimated to be around €42 M. (Deloitte, 2015) The additional entrepreneurial activity also holds benefits for North-Brabant too. A study by the Kauffman Foundation found that new business (i.e. start-ups) account for nearly all of *net new* job creation and almost 20% of gross job creation. (Kauffman Foundation, 2010) Based on the economically active population and GDP per inhabitant in North-Brabant, the creation of a new entrepreneurial ecosystem around data science could translate to approximately

"[Based on the economically active population and GDP per inhabitant in North-Brabant], the creation of a new entrepreneurial ecosystem [around data science] could translate to at least €950 M of economic impact"

€950 M in economic impact. (Eurostat, 2013) At the European Union (EU) level, data science could propel GDP growth by an additional 1,9% by 2020 due to big and open data. (DemosEUROPA, WISE Institute, Microsoft, 2014)

Several things factor into the development of an ecosystem successful. As the GRIDS builds its data science ecosystem, there are several items for consideration:

- Access to risk capital for the successful start-up and SME community
- Access and retention of world class talent
- Balance and diversity of industries and company maturities
- Knowledge infrastructure

While these exist in North-Brabant to a degree, the GRIDS will continue to galvanize each and enable North-Brabant's innovative entrepreneurs of tomorrow.

Taking steps towards success

Planning for the facilities in Mariënburg is already well underway with the identification process of the scientific director and staff in progress. The brands of TU/e and TiU can be leveraged to recruit students and the ecosystem at large. Joint external communications and alignment will also ensure a consistent brand and experience from a student and researcher perspective.

In the educational and research programs, there will be collaboration between TU/e, TiU and Graduate School Data Science Mariënburg. Although GRIDS is already well-connected with the ecosystem, education and research programs improve the ability to attract, retain and grow industry. Moreover, Triple Helix governance will ensure that the programs remain in-line with the priorities of business and society.

The future: creating excellence

The vision for the GRIDS is to establish a fully integrated ecosystem amongst Triple Helix stakeholders. Open innovation and collaboration will be core attributes of the ecosystem around GRIDS. Innovative projects with ecosystem partners will be linked with North-Brabant and European-level priorities and research. These activities will bring benefits in terms of job creation, spin-offs and new, data-driven business models for its businesses and organizations.

As previously mentioned, the Graduate School Data Science Mariënburg will act as a front-office for marketing and branding the data science ecosystem and business development for the initiative in

North-Brabant and internationally. Down the line, the knowledge valorization organization could evolve into a hybrid ecosystem enabler (an embedded organization that combines attributes of an incubator and an accelerator) creating starts-ups and providing project-based services for ecosystem partners. The GRIDS will also seek extend its ecosystem abroad to developing collaborative relationships with international partners (e.g. Cambridge Innovation Center) including businesses, academic institutions, etc.

With the ambition to open the school in September 2016, a number of key decisions remain from regulatory bodies. In addition, the setup or implementation of the school needs to be initiated.

Conclusions and recommendations

To be successful, the GRIDS needs to secure first-mover advantage on the competition. In addition, it must follow through on its ambition and design (ecosystem embeddedness). Creating a hybrid enabler provide the opportunity to develop new business models, solutions and companies; as well as the opportunity to enrich the SME-community in the North-Brabant region. With the right mechanisms the GRIDS initiative is well positioned to succeed given Triple Helix collaboration and well-established institutions supporting it.

1. The GRIDS and Graduate School Data Science Mariënburg goals and aspirations

In this section of the report, the goals and aspirations for GRIDS and Graduate School Data Science Mariënburg are outlined. For each of the universities, this initiative can strengthen their research profiles making them a more attractive option to students. 's-Hertogenbosch will benefit in a couple ways, including: an inflow of talent and creative minds and an attractive new site in the city for students, vesting scientists and companies. The city of 's-Hertogenbosch will also benefit from maintaining the cultural heritage of the site in Mariënburg. Business and society in the region can benefit from the resulting new businesses and business models.

1.1 Mission

The Mission formulates the founding purpose of the GRIDS and the Graduate School Data Science Mariënburg. It articulates why they exist and captures the soul of the organization:

Understanding and advancing the value of data in solving complex societal and business challenges.

1.2 Vision

The Vision is specified for both the GRIDS and Graduate School Data Science Mariënburg and should represent a clear and vivid description of the high-level goals of the organizations.

Vision of the GRIDS:
The GRIDS serves as an ecosystem in the province North-Brabant, focusing on value creation for business and society based on data insights with a foundation in education and research.

Vision of the Graduate School Data Science Mariënburg:

The Graduate School Data Science Mariënburg develops entrepreneurial and innovative data scientists equally versed in performing cutting-edge scientific research and applying it to the most pressing societal and business challenges in a collaborative ecosystem, stimulating a stream of new scalable (or exponential) business models in Brabant.

1.3 Shared values and guiding principles through education, research & the ecosystem

The values and guiding principles that are unique to the organization:

- Strive for excellence in everything – excellent data scientists, researchers, faculty and (societal) entre- / intrapreneurs. Our alumni will become great ambassadors and contributors to the ecosystem
- Deliver high end education, research and valorization of the highest ethical standards
- Create a positive business and social impact and attitude to address their challenges
- Build a knowledge hub for the future
- Inspire the ecosystem partners and serve as a catalyst to fuel innovation as an embedded entity
- Chase big dreams and opportunities with datapreneurial behavior in all that we do

1.4 Objectives

The Objectives define the medium-to long-term goals for the GRIDS and Graduate School Data Science Mariënburg, specified for education, research and valorization. Various GRIDS participants will derive value from the initiative through the achievement of the common objectives below. While certain objectives are more relevant for specific stakeholder groups, it is important to consider them holistically to enable a successful ecosystem.

- Educate students as interdisciplinary and entrepreneurial data scientists
  - GRIDS and Graduate School Data Science Mariënburg
    - A joint BSc Data Science, offered at both Eindhoven University of Technology and Tilburg University
    - An MSc Data Science Business & Society, offered at Tilburg University
    - An MSc Data Science Engineering, offered at Eindhoven University of Technology
    - A joint MSc Data Science & Entrepreneurship, offered by Eindhoven University of Technology and Tilburg University at the Mariënburg monastery in 's-Hertogenbosch
- Develop T-Shaped researchers, with a technical foundation and the skill-sets to link with teams, industry and entrepreneurs; who can address the evolving business needs and societal challenges, while leveraging the strong foundation of TU/e and TiU in 's-Hertogenbosch
  - GRIDS and Graduate School Data Science Mariënburg
    - *30%* of incoming students will be *international students*
    - *MSc in Eindhoven and Tilburg*: joint inflow of *100 – 150 students per year at each master's site*
    - *Joint Bachelor's* inflow target is *200 students per year*
    - Inflow in the first year of *60 students* for the MSc – Entrepreneurship, PDEng program, and PhD combined
    - Grow to *inflow of 140 students per year*
- Become a first mover in interdisciplinary data science education
- Become a disruptive force by staying ahead of ecosystem trends and challenges
- Become a valorizing force and fuel economic growth in the North-Brabant Region, especially the cities of 's-Hertogenbosch, Tilburg and Eindhoven
- Develop a strong brand related to data science and innovative entrepreneurship on a European and international basis
- Develop a strong funding pipeline through grants & incentive schemes including Horizon 2020 and Nederlandse Organisatie voor Wetenschappelijk Onderzoek (NWO)

2. Where the GRIDS and Graduate School Data Science Mariënburg will focus

This chapter contains information on the areas where the GRIDS and Graduate School Data Science Mariënburg will focus. As a higher education initiative, there are a number of core functions and stakeholders to be served such as students, researchers, faculty and the ecosystem. Similarly, there are also a set of core offerings (i.e. products and services) that GRIDS and the graduate school will provide. Beyond these core activities, the initiative is designed to closely collaborate with the business ecosystem in North-Brabant. The total package including its international ambition and comprehensive programs in education and research hold the potential to differentiate GRIDS from competitive initiatives.

2.1 Customers / "Beneficiaries"

Multiple players (people and organizations) will benefit from GRIDS's structure through education, research and ecosystem participation. Ecosystem partners will be heavily involved in research programs with GRIDS students. Their input and challenges will play an important role in shaping the educational program and curriculum from year-to-year so that GRIDS participants can provide the best, most relevant experiences to students. Furthermore, strong linkages to ecosystem organizations (companies, government, etc.) will calibrate demand and focus research on the most relevant direction.

The majority of students and researchers will come from North-Brabant and the Netherlands, the goal is for a significant percentage of students (30%) to be international. Domestic and international students are further segmented into high school – i.e. the students the undergraduate program is targeting, undergraduate (Bachelors) and graduate (Masters, PhDs). GRIDS will also provide continuing education programs to professionals, in the Netherlands and abroad. While the students can individually be segmented in a similar fashion to the high school, undergraduate and graduate students; organizations or ecosystem partners could also approach GRIDS for these types of programs meaning that segmentation can apply to continuing education as well. An overview of the ecosystem and educational customer segmentation is outlined below.
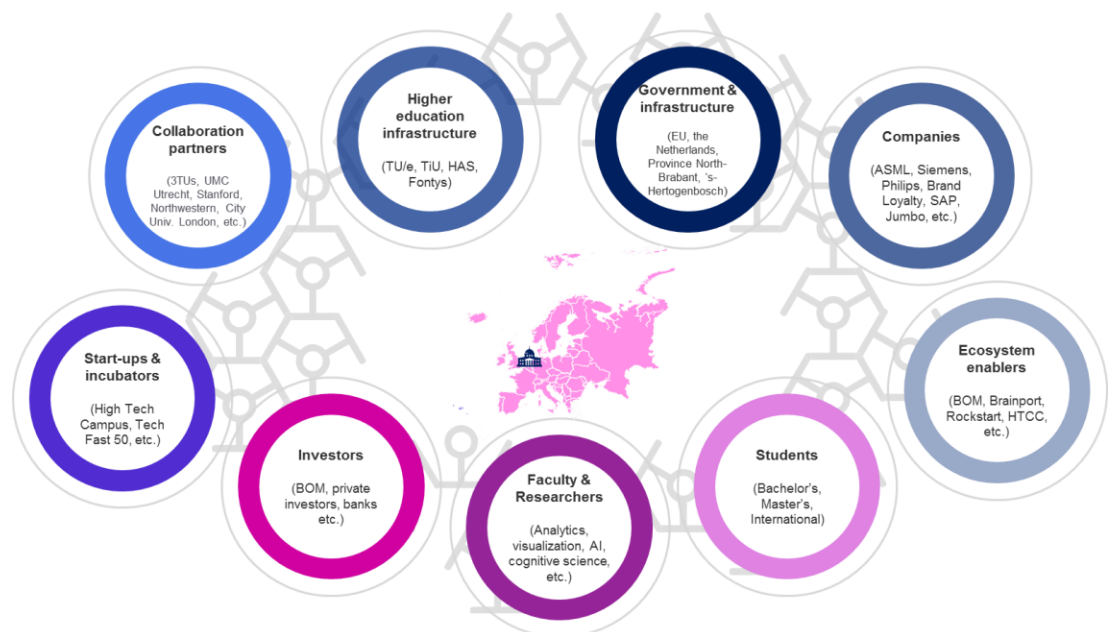

Figure 1. Representative ecosystem stakeholders

Thus, GRIDS can be separated in two broader segments – the ecosystem partners who work closely with the initiative in terms of research projects with students, funding, events, etc.; as well as the

students and researchers who are educated and perform research via the institutions involved in the initiative. A view of the customer segmentation can be found below:
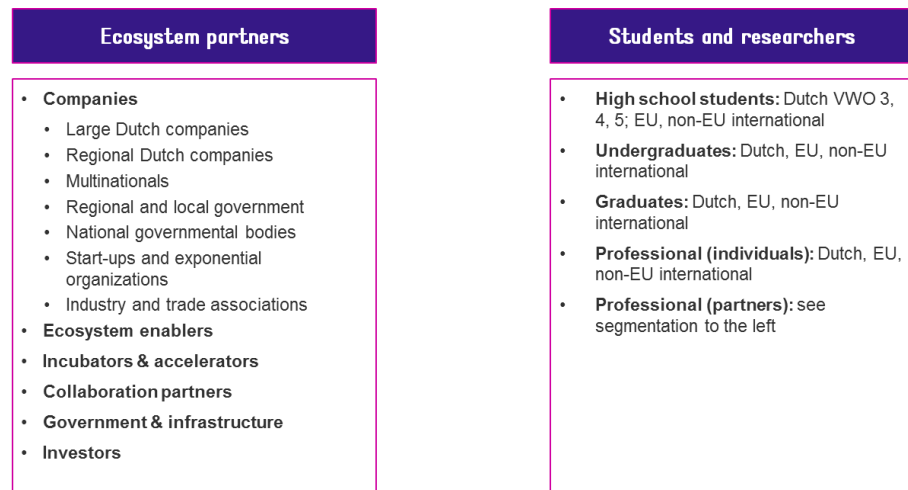
Ecosystem partners	Students and researchers

• **Companies**
  • Large Dutch companies
  • Regional Dutch companies
  • Multinationals
  • Regional and local government
  • National governmental bodies
  • Start-ups and exponential organizations
  • Industry and trade associations
• **Ecosystem enablers**
• **Incubators & accelerators**
• **Collaboration partners**
• **Government & infrastructure**
• **Investors**
	• **High school students:** Dutch VWO 3, 4, 5; EU, non-EU international
	• **Undergraduates:** Dutch, EU, non-EU international
	• **Graduates:** Dutch, EU, non-EU international
	• **Professional (individuals):** Dutch, EU, non-EU international
	• **Professional (partners):** see segmentation to the left

Figure 2. Segmentation between partners and students, researchers

In many ways, ecosystem partners are both providers (propelling the ecosystem forward, and consumers (using facilities, services, labor and the presence of the GRIDS to their own competitive advantage) of GRIDS services. The students and researchers educated at the GRIDS institutions can perform research on behalf of themselves, their schools and the broader ecosystem.

2.2 Products & services

Traditional educational and research products will be offered via the three different schools participating in GRIDS. Fundamental research programs, as well as those carried out in cooperation with partners, will be a standard, but critical component of the research offering.

Table 1. Educational offerings

Educational offerings	**Education at TU/e and TiU:**
	  • Joint Bachelor Data Science at TU/e and TiU
	  • Master Program Data Science Engineering (TU/e)
	  • Master Program Data Science Business & Society (TiU)
	  • PDEng Data Science Program Eindhoven (TU/e)
	  • PhD Program Data Science TU/e
	  • PhD Program Data Science TiU
	
	Education at Graduate School Data Science Mariënburg:
	  • Master Program Data Science Entrepreneurship
	  • PhD Program Data Science Mariënburg
	  • PDEng Data Science Program Mariënburg
	  • Professional Development Courses Mariënburg
	  • Executive Programs Mariënburg

The educational offering will consist of programs in Mariënburg (Graduate School Data Science Mariënburg), Eindhoven (TU/e – DSC/e) and Tilburg (DSCt – TiU). The combined GRIDS programs will offer a differentiated, multi-disciplinary education that it is truly unique amongst global data science programs.

These four programs unite three focus areas: society, engineering and entrepreneurship. Each program is having its own specific focus.

In the **Bachelor's program (1)**, the focus areas are addressed in a balanced manner in order to provide a broad basis for future studies in the master's program.

The **joint MSc Data Science & Entrepreneurship (2)** aims to educate innovative entrepreneurs who can create new products and services, or contribute to their development. The program is based on four pillars: data science, entrepreneurship & innovation, business and law & ethics.

The **Tilburg MSc Data Science & Business and Society (3)** combines expertise on data mining, pattern recognition, business analytics and visualization with knowledge on law, regulations, ethics and entrepreneurship. In this way, the program offers an economic and managerial perspective on data science, as well as the juridical, ethical and methodological aspects involved.

The **Eindhoven MSc Data Science Engineering (4)** combines Mathematics and Computer Science, providing a deep engineering perspective in data science. Besides Data Mining, Visualization, Advanced Process Mining and Advanced Algorithms, students are trained in Statistics for Big Data and Probability and Stochastic processes.

Table 2. Research offerings

Research offerings	- Academic Publications - Joint Research - Contract Research - Joint PhD projects - Sponsored Chairs

For these purposes, fundamental research will be defined as a systematic study directed toward greater knowledge or understanding of the fundamental aspects of data science without scientific applications towards processes or products in mind. (National Science Foundation (U.S.), 2010) Fundamental data science research can be performed independently for publication in academic periodicals or through joint and contract research with ecosystem partners. In addition, ecosystem partners will be able to sponsor the research of chairs throughout the initiative (i.e. at Mariënburg, TU/e and TiU).

The knowledge valorization organization will provide ecosystem products and services creating value for the data science ecosystem. Products and services (e.g. collaborative data initiatives) will be available to the ecosystem, which includes small & medium enterprises (SMEs) as well as established corporate partners.

Depending on the initial needs and maturity of the ecosystem – or the desires of the initiative stakeholders, the knowledge valorization organization can be scaled up or down. If the primary needs of the ecosystem are solely human capital related, then an organization with a wide-range of services will be less necessary.

The knowledge valorization organization will offer a number of core services to its ecosystem partners, including internships, project-based collaborative data initiatives and the temp program.

- *Internships* - Ecosystem partners can connect with and provide internship opportunities to GRIDS students. This program is open to students at the BSc and MSc levels and would be offered to ecosystem partners free-of-charge as part of their sponsorship funding.
- *Collaborative data initiatives* – It can build up a team of data science advisors connecting its talent (students) from the BSc, MSc, PDEng (more detail on the PDEng program can be found 2.4 Fundamental and applied research programs), and PhD to organizations and research programs that require support in data science fields in the ecosystem. Fees would be charged in a similar fashion to other for-profit organizations. An important part of the agreement with partners is that solutions, methodologies, techniques, etc. could be repackaged and reused as a product or on a subscription basis in the future.
- *Temp program* - It can offer data scientists via its various educational programs on a temporary basis to early-stage companies and other ecosystem partners (of various sizes) in need of surge support at a fee and agreed period of time.

The knowledge valorization organization is a one-stop shop for GRIDS, which creates value for its key stakeholders:

- **For Province North-Brabant:** It will establish a strong bridge to industry and foster entrepreneurship and drive a positive social impact
- **For 's-Hertogenbosch:** establishing a front-office located in Mariënburg, it will contribute to strengthening the image of the city as a data science epicenter in the region
- **For both universities (TU/e and TiU):** It will address both attractiveness aspects for new students and researchers by providing a platform for connecting with industry, becoming a

breeding ground for early-stage companies AND enhancing the ability to benefit from applied, theme-drive research in close collaboration with each industry

Especially in data science, the ecosystem services make it an enabler to the ecosystem.[2] Given the level of ambition and overall objectives of GRIDS initiative, the setup of the knowledge valorization organization holds the potential to strengthen the overall positioning of the ecosystem.

2.3 Geographies

At least initially, GRIDS will operate in a concentrated regional geography – North-Brabant – in the cities of Eindhoven, Tilburg, and 's-Hertogenbosch. The Data Science Centers (DSCs) at Eindhoven and Tilburg will draw on the facilities and infrastructure of TU/e and TiU respectively. Graduate School Data Science Mariënburg will be an additional location designed to enhance ecosystem for several strategic reasons.

- The location further north makes it an appealing location to those around the province of North-Brabant (e.g. Utrecht, Amsterdam, etc.)
- The city of 's-Hertogenbosch is a unique, historical city in the history of the Netherlands that can appeal to several sets of customers
- A physical presence in 's-Hertogenbosch also provides a platform to bring 's-Hertogenbosch-located ecosystem partners into the initiative
- A centralized location in 's-Hertogenbosch that is attractive to the students and local residents

In addition to these operating geographies, there are wider geographies to consider when marketing to students, potential faculty and ecosystem partners. To match its international ambitions, GRIDS must understand and compete with similar initiatives and ecosystems at a national, European, and global level in multiple dimensions.

The Netherlands and Europe

Through the combined efforts and reputation of TU/e and TiU, GRIDS is a visionary initiative that seeks to become one of the top education and research institutions in Europe. Furthermore, the initiative would like to create a data science education that is appealing on a global scale. To win in this regard, GRIDS will need to compete with several other similar programs that have strong reputations in the technical sciences and education more broadly (detailed information found in Appendix: Peer institution comparison).

There are schools throughout the continent of Europe with strong data science related programs already being offered (ETH Zurich, KU Leuven, TU Berlin, etc.) or in development (University of Amsterdam). While many are strong in the education of data science, mathematics, statistics, etc.; they lack the deep technical knowledge and unique relevance to business and society that is integral to GRIDS education. Additionally, they lack the research and ecosystem embeddedness available in GRIDS.

From an international perspective, GRIDS will have to compete with strong data science, analytics and computational science programs in the United States. As with the programs above there are no specific data science linkages in applied research and the ecosystem as with in GRIDS. That said – especially in the instances of Harvard and Stanford – many of the American programs have strong relationships with their surrounding ecosystems from a broader (i.e. non data science perspective).

To achieve its ambition GRIDS seeks to establish a 'self-propelling' ecosystem that is differentiated amongst benchmark ecosystems in Europe. While the initiative is building a data science ecosystem, it is certainly possible to create vibrant ecosystems combining a variety of different factors and conditions. Within Europe, the ecosystem has been compared to Leuven, London, Munich and Tel Aviv. Looking at these ecosystems, they are of similar size in terms of population (between 1,5 to 2,6 M) with the exception of London. London and Tel Aviv are well-regarded globally as ecosystems (#2 and #7 respectively), while Munich and Leuven have strong technical universities and industry connections. (Startup Genome and Telefonica Digital, 2012)

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[2] Realizing the full benefits of the knowledge valorization organization is dependent on the availability of support and enablement resource. If it is not setup during the start-up of GRIDS than its value to the ecosystem will be limited to facilitating relationships between the GRIDS and the ecosystem (marketing, human capital, etc.)

Table 3. Basic dimensions of European ecosystem benchmarks (Eurostat, 2010) and (Euromonitor International, 2014)

	Population	Universities	GDP (in billions Euro)
GRIDS	1.500.000	TU/e and TiU	€ 86 (Brabantstad)
Leuven	1.830.000	KU Leuven	€ 125
London	9.787.426	Oxford, Cambridge	€ 505
Munich	2.606.021	TU Munich Ludwig Maximillian University	€ 129
Tel Aviv	1.339.238	Tel Aviv University	€130

To compete, GRIDS can combine current strengths with lessons learned from these ecosystems into a complete package. It can develop characteristics of places like London and Tel Aviv, while leveraging its already strong ties to industry similar to Munich and Leuven. One added value that the GRIDS offering will use to differentiate itself from these ecosystems is the application to business and society at the Graduate School Data Science Mariënburg location, as well as the sheer number of students it will supply the labor market. Although it will be difficult as the other European ecosystems are more entrenched, the GRIDS total package (strong knowledge infrastructure, ecosystem embeddedness, entrepreneurship, etc.) is compelling for students, faculty and organizational partners alike.

To become an ecosystem with international allure, GRIDS will also need to consider its positioning versus established ecosystems like Silicon Valley and Boston or ecosystems focusing on data science like Melbourne. While these ecosystems have larger populations and GDPs, the key success factors that apply there may also apply to GRIDS. Additional detail on international ecosystems can be found in the Appendix: Ecosystem comparison and key success factors are discussed in 3.2 Sources of defensible competitive advantage.

Table 4. Entrepreneurial activity in the European Union (2011) (Telefonica, 2013)

	Germany	France	U.K.	Italy	Spain	Netherlands	Sweden
Total entrepreneurial activity	5%	5%	9%	4%	6%	10%	6%
Start-up programs	31	35	50	23	38	21	22

To-date many European ecosystems are geared towards entrepreneurism and start-ups in general without specializing in a theme, industry, or lifecycle. (Telefonica, 2013) This is an area where GRIDS could build an advantage on the competition. While the applicability of data to business and society is certainly broad, the focus of the ecosystem on data science as well as the application to themes is a differentiating factor compared to other ecosystems. From this perspective, the knowledge valorization organization can serve the ecosystem by facilitating knowledge sharing between data science experts, encourage technical build-up to reduce the learning curve in the region and build on economies of scale. (Telefonica, 2013) In other words, it can create a critical mass in data science in the North-Brabant region that would difficult to achieve without this specialized focus.

2.4 Vertical components in the 'student value chain'

In the realm of data science, the GRIDS is unique in that it is connected to each different components and programs offered in higher education. As outlined below, GRIDS is developing data science-focused offering in standard educational offerings (e.g. BSc, MSc & PhD), research and continual education programs.

Common educational elements (BSc, MSc & PhD)

The core educational program of GRIDS is unique due to its emphasis on students having a strong basis in one discipline with knowledge of at least one other field. This multi-disciplinary approach is unique and the educational programs throughout the initiative are structured in such a way. There are

four programs designed to unite the three focus areas of the initiative: business and society, engineering and entrepreneurship with each program having its own specific focus.

- The Bachelor's program where business and society, engineering and entrepreneurship are addressed equally
- The joint MSc Data Science & Entrepreneurship
- The Tilburg MSc Data Science & Business and Society
- The Eindhoven MSc Data Science Engineering

Each of these programs is stronger, because it is part of a holistic offering that provides students and faculty the opportunity to focus on the content (business and society, engineering, entrepreneurship) and application of data science (theme) that is most interesting.

Fundamental and applied research programs

The GRIDS will have two distinct research offerings: fundamental and applied. While both forms are important, they are carried out in a very different manner – and will be performed within a different part of the GRIDS. For the purposes of the initiative, applied research will be defined as systematic study to gain knowledge or understanding in order to determine the means by which a recognized and specific need may be met. (National Science Foundation (U.S.), 2010)

Fundamental data science research will be performed through the GRIDS, but applied research will be performed via the knowledge valorization organization. Via this organization, partners can interact with the new breed of 'T-Shaped' students and faculty with a track record in entrepreneurship or business, combined with data science expertise.

The research environment in 's-Hertogenbosch should be closely connected to the Data Science Centers at Eindhoven and Tilburg. Challenges that are sourced from the ecosystem should be readily shared between the centers and lead to synergy in the capabilities of the cluster. Research will be conducted in the Data Science Centers of Eindhoven and Tilburg, as well as in the graduate school in 's-Hertogenbosch. The research themes will be closely aligned with data science, tomorrow's challenges and the market needs of the region. The existing data science centers at TU/e and TiU already have established their research themes.

The Post-Doctoral Engineering Data Science (PDEng) program is an additional differentiator where national and international graduate master's students can train as lead engineers in the field of data science. Part of this two year program in 's-Hertogenbosch is a 12 month project in the 'field' with an ecosystem partners for a fee. With a steady state flow of 20 PDEng's to the ecosystem, the ambition is to create 200 lead engineers over the next 10 years. Based on our benchmark educational programs (additional detail in Appendix: Ecosystem comparison), the PDEng is also unique from an international perspective in that it closely links students and study of data science to business.

By basing the research topics on tomorrow's societal and business challenges, 's-Hertogenbosch can become the place to find deep know-how and hands-on experience in data science.

Continuing education

The rapidly changing business environment causes skills to become obsolete more quickly. Increasingly students must continuously refresh their skills and in turn, provide additional value to their teams, organizations, and ecosystems. (Deloitte Center for the Edge, 2013) The GRIDS is designed to bridge this gap by offering a permanent education curriculum. These courses and seminars will be developed and taught to the ecosystem at each physical locations based on the nature of the audience (business and society, engineering, entrepreneurship). Each course or seminar can be delivered to these partners from their own perspective and apply the latest business thinking in a far more compressed timeframe than the other educational programs.

In comparison to the budget identified in the U.S. and U.K. based organizations, large organizations in the Netherlands spend twice as much on learning and development. (Learning and Development Trends in the Netherlands) To create value for the ecosystem, the GRIDS can assist Dutch and Dutch-based companies to reduce their learning and development costs, providing additional data science expertise that is not present at the organization.

3. How GRIDS will succeed

Tailored theme-based ecosystems

This initiative is designed around seven theme-based pillars that go beyond the broader study of data science into the context and application to specific topics / industries. While the topic of data science will be core to the high-level ecosystem in the region, specific trends and challenges will required a more focused approach integrating data science into the strategic and operational realities of the business or organization. These theme-based 'micro-ecosystems' will work together to propel the ecosystem and understand the impact of data science on their theme.

Themes were selected based on the following criteria:

- Is the theme data-driven?
- Is the theme appealing to the broader market? Are there opportunities for start-ups?
- Is it inter-disciplinary and inclusive of data science?
- Can each of the universities (TU/e, TiU and the Graduate School Data Science Mariënburg) contribute to the topic? Is it relevant to existing research areas at TU/e and TiU? Does it appeal to prospective researchers?
- Is the name attractive to students, researchers and the ecosystem?

Theme	1. Bionic Brains and Amplified Intelligence (Finance, insurance and Law)
Related fields	• Accounting and auditing • Finance and Banking • Insurance • Law
Description	The application of Data Science has the potential to partially or fully automate previously unaffected knowledge activities.
Key value drivers	The key reasons that these organizations value data scientists are their ability to: • Analyze text-based data in efficiently and accurately in previously unmanageable quantities • Process both structure and unstructured data • Make connections between disparate data sets • Apply lessons learned to future analyses to increase efficiency

Theme	2. The Connected Wellbeing Journey (Personal care and wellbeing)
Related fields	• Wellbeing and care • Consumer technology
Description	This theme is about leveraging data and data science techniques in enabling personalized wellbeing, an active and healthy lifestyle through the quantified self.
Key value drivers	Research on personalized medicine, DNA sequencing, patient engagement, Quantified Self enable an unprecedented view of the patient. The value provided by data science is due to the fact it can: • Analyze text-based wellbeing data in efficient, accurate and previously unmanageable quantities • Process both structured and unstructured data from multiple sources (consumer wellbeing devices, monitoring device, health IT databases, etc.) • Make connections and analyze disparate data from wellness devices & apps, monitoring devices, medical databases, and other clinical data • Monitor non-intrusively biomarkers and body functions and feeding back information

Theme	3. Data Analytics of Things (Productivity and maintenance)
Related fields	• City management & control • Productivity & maintenance • Logistics • Industry 4.0
Description	This theme is closely connected to the Internet of Things and its driving innovations. In 2015 1 B wireless Internet of Things devices will be shipped. An installed base of 2.8 B devices will generate large amounts of data, and thus data analytics will drive smart industry, smart mobility, smart logistics, and smart cities.
Key value drivers	This theme focuses on the Internet of Things and its innovations. An explosion in the amount of connected devices will create more data. The ability to collect and analyze data will drive successful organizations in smart mobility, smart logistics, and smart cities. In particular, Data Science unlocks value through its ability to: • Process both structure and unstructured data • Connect and analyze disparate data from billions of devices • Link data gathered to develop virtual models and simulations for historical and predictive analysis (can improve maintenance, reduce downtime, etc.) • Gather real-time or near real-time insight into plant, road, city conditions • Monitor performance remotely and enabling long-distance control and maintenance • Enable adaptive public space support by urban service management and commissioning

Theme	4. Feeding the Planet Using Data (Agro and food)
Related fields	• Agro • Food • Nutrition
Description	This theme is about data science challenges in the field of agriculture, food, nutrition, water and sustainability aspects.
Key value drivers	Several of society's challenges are related to agriculture and food. Data science can offer answer to these challenges in order to: • Provide square meter by square meter data and analysis of fertilizing, farming, techniques, etc. AND connect it with farmer machinery • Utilize massive amounts of data associated with genome mapping of biological organisms to understand the basic building blocks of food • Utilize vast amounts of supply chain and operations data to reduce food waste in the supply chain and improve supply chain performance • Provide decision support by correlating information from different life-science related sources

Theme	5. Data Quest for the Customer Journey (Data-driven branding and marketing)
Related fields	• Marketing • Branding • Cognitive science
Description	Data and cognitive technology is changing the playing field of marketing and branding, and offer new ways to create value and enhance the consumer experience. Technology and data are being used to empower consumers and instill confidence in purchases. In addition social analytics monitor and predict consumer behavior
Key value drivers	Data and cognitive technology is changing the playing field of marketing and branding, and offer new ways to create value and enhance the consumer experience. • Analyze customer behavior, mapping needs to business propositions • Aggregate and analyze text data from disparate social media sources can be to monitor consumer behavior • Offer predictive insights rather than historical observations • Make decision-making easier, more effective based on digital marketing data

Theme	6. Connecting the modern city (City management and control)
Related fields	• City government • Construction • Infrastructure • Telecom • Transport and Logistics
Description	Enabling adaptive support and understanding of urban areas through connecting and understanding infrastructure more effectively, as well as engaging citizens more actively.
Key value drivers	By creating a connected city based on data, municipalities can understand and predict outcomes better. These insights can then be applied to policy and decision-making improving the functionality and livability of the urban environment. • Understand traffic and travel patterns to make more efficient use of travel infrastructure • Connect and analyze (previously unconnected, misunderstood) components of city infrastructure (power, water, etc.) • Improve the intelligence of municipal institutions through data analysis and predictive capabilities

Theme	7. Monetization of data (Data entrepreneurship and data value)
Related fields	• Exponential organizations • Insurance • Airline industry
Description	Data is creating new business opportunities. Breakthrough applications of innovative technologies to traditional industries causes disruption (e.g. Airbnb), capitalizing on new opportunities and new markets fuels exponential growth of new businesses (e.g. social networks).
Key value drivers	This theme aligns closely to the core of the GRIDS (data science and entrepreneurship) and to knowledge in both Eindhoven and Tilburg. It also offers a good match with the exponential organizations that will be part of the ecosystem. The value of the GRIDS is to: • Understand what value data can deliver for businesses • Create new business models on monetization of data • Utilize data to disrupt established industries

3.1 Value proposition

Providing the talent of the future

The programs offered within the cluster aim to develop T-shaped students (see Figure 3) offer an interdisciplinary approach, which is a key point of emphasis across the programs. All students will have a strong basis in one discipline with knowledge of at least one other field. They are therefore able to make connections and approach problems multi-dimensionally requiring creative-thinking and problem-solving abilities that will differentiate them from their peers. Few programs in data science in the Netherlands or globally exist with such a strong interdisciplinary approach.

Due to the embeddedness of the GRIDS within the data science ecosystem, students will gain experience in solving real-life problems. This business and social relevance is combined with a unique program that develops a brand new breed of student. The action-based learning program means that students can distill their insights into concise and practical advice for the non-technical, while possessing a strong level of understanding that enables to work with the highly technical.

The close link to the ecosystem is important as this new type of talent will be able to analyze and distill the most relevant data. This new data scientists will be able to understand the impact on the current business and reimagine new business models, whilst ensuring legal and ethical boundaries are observed.
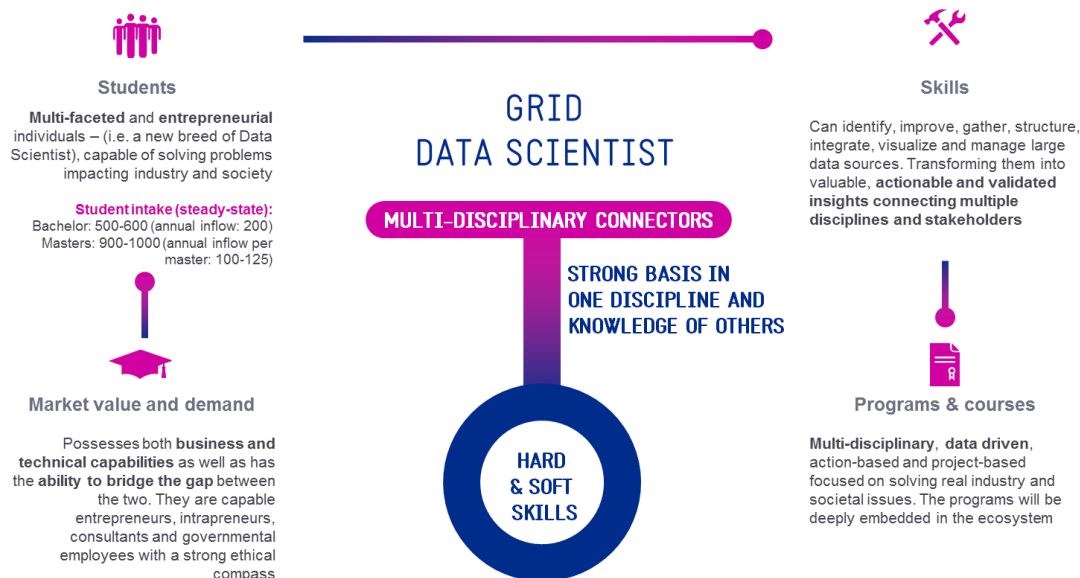
Figure 3. T-shaped GRIDS Data Scientist

The way students accumulate knowledge and build skills is innovative. The Master's programs are tailor-made yet modular, to appeal to modern students. The programs are dynamic and agile, addressing the evolving business needs and societal challenges. By using activating didactical methods, including data sets in each course and by structurally connecting to the industry, the cluster provides in stimulating learning experiences.

The cluster has opportunities for other learning activities besides these traditional Bachelor's and Master's program; the institute is keen on developing lifelong learning activities. These can include executive training on data-based leadership and decision-making, and data science (refresher's) courses on the latest methodologies, jurisdiction and ethics for data science professionals.

Deeply embedded in the ecosystem

It is an ambition of the GRIDS to make the data science research performed at the institutions relevant to business and society. The GRIDS is an example of an initiative between government, industry and academia that can benefit the region and country as a whole. This collaborative approach can help address the challenges such as the current gross domestic R&D spending gap between the Netherlands and its peer Organization for Economic Co-operation and Development (OECD) countries.
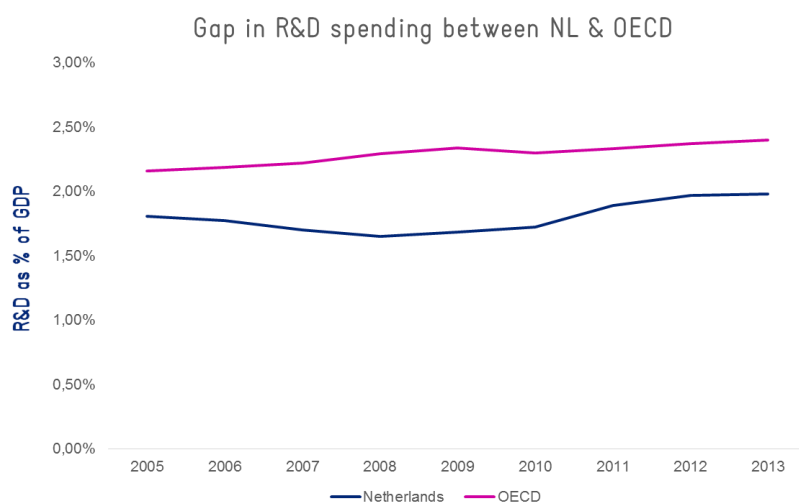

Figure 4. Gross Domestic R&D Spending Gap (OECD, 2015)

In doing so, the GRIDS and the ecosystem can join forces to bridge the gap on R&D spending to address the challenges facing Dutch businesses and society. The GRIDS can become a platform for applied research and share R&D investment risk amongst academia and industry within the ecosystem.

Research will also be linked to current regional capabilities, tomorrow's challenges and opportunities for the North-Brabant region. The GRIDS can augment the RIS3 strategy (RIS3 Zuid, 2013) for the region – strengthening its value proposition through close alignment to the Triple Helix of organizations (research, industry and government). Several components of the school will also strengthen the region's ambition to:

- Become a testing ground for applying an scaling knowledge technologies via the GRIDS research programs and the knowledge valorization organization
- Develop an open-innovation ecosystem as the operating model for the GRIDS are designed with collaboration in mind
- Consolidate on the regions competitive advantage versus others within Europe – the broad applicability and ability of data to enhance business and society can further strengthen the region in this regard
- Strengthen the ecosystem through valorization with large businesses, SMEs and the knowledge valorization organization

Scale and ambition of the initiative to meet high demand

The sheer scale and ambition of the GRIDS is one of a kind and is of clear value to the ecosystem in the region. In a steady-state, the initiative is designed to accommodate an estimated total of 1.500 students per year between the three sites.[3] In addition, the Master's programs will produce about 300 students per year to become data scientists in the ecosystem. As the program matures, it will begin addressing the aforementioned data scientist shortage in the Netherlands – creating a strong flow of talent to reduce this skills gap. As research by Dialogic notes, the number of vacancies in the Netherlands for data scientists nearly doubled between 2014 and 2015, with a trend expending to continue. (Dialogic, 2015)

The GRIDS also represents an opportunity for the North-Brabant to help the Netherlands close the gap in key human capital & research indicators. According to *The Global Innovation Index 2014*, the Netherlands is #59 in tertiary education and #89 in the percentage of graduates in science and education. (Dutta, Lanvin, & Wuncsch-Vincent, 2014) While there are obviously a variety of factors that comprise these indicators, the unique blend of business and technical skills can help the Netherlands improve on these key indicators and improve its competitiveness.

Modular themes of focus that adapt to ecosystem challenges

Educational and research themes of focus have been designed for the real world. The GRIDS partners face business and societal challenges that are constantly evolving, not static. The theme-based micro-ecosystems are designed to inform education and research programs so that GRIDS is equipped to keep up with the world around it. This modular approach to curriculum development and link to applied research represents a source of real value for both the initiative and the ecosystem.

Reinforcing North-Brabant as an innovative environment

Data science and by extension the GRIDS reinforce the existing strengths and policy goals of North-Brabant. In addition to addressing North-Brabant's challenges (Provincie Noord-Brabant, 2015), it provides an opportunity to consolidate on its reputation as the most innovative region in Europe. (Eurostat, 2012) The creation of the graduate school along with its space for knowledge valorization also creates a new data science cluster for the province further galvanizing the ICT community around it in 's-Hertogenbosch. (Provincie Noord-Brabant, 2012) The cluster will also be enabled by North-Brabant's digital agenda, which provides quality broadband internet through the province. (Provincie Noord-Brabant, 2013)

The theme-based micro ecosystems closely relate to the provinces established top sectors including Agro & Food, High-Tech, Logistics, Energy, eHealth and fostering SMEs. (RIS3 Zuid, 2013) Data – and data science – is a key enabler across industries. It can used to drive more efficient operations or provide greater insight into performance as to enhance forward looking decision-making. The table below highlights data-driven developments in each of these top sectors.

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[3] Current student population estimates requires v alidated with TU/e, TiU and appropriate regulatory bodies

Table 5. Recent data science developments in North-Brabant top sectors

	Theme	Recent development[4]
Agro & food	Feeding the planet using data	Monsanto bought Climate Corp. and 640Labs to perform crop analytics on how much seed, fertilizer, etc. is appropriate. It also uses GPS data to ensure the right amounts are used.
eHealth	The connected wellness journey	Philips is using data to build a digital health platform bringing in data from various sources to advanced and eventually allow for data-enabled, personalized medicine.
Energy	Data analytics of things Connecting the modern city	Rockwell Automation (an oilfield services company) is using sensors to provide data on equipment performance to engineers, as well as further downstream as it is transported to the consumer. Engineers have digital 'dashboards' that shows related data for real-time analysis.
High-Tech	Data analytics of things	A global jet-engine manufacturer is using new data streams from sensors to improve maintenance services and reduce engine recovery times.
Logistics	Data analytics of things	Amsterdam Schiphol international airport uses transmitters to track real-time location, usage and equipment data that can be used from operationally – and more importantly, for analysis to improve logistics at the airport.
SMEs	Data entrepreneurship & value	One of Airbnb's projects uses machine learning to learn hosts' preferences for accommodation requests based on their past behavior.

The unique value proposition of the GRIDS and the enabling nature of data science can help build upon North-Brabant's industrial strengths across the top sectors, while building a new economic center of gravity in 's-Hertogenbosch.

3.2 Sources of defensible competitive advantage

The GRIDS provides the Netherlands with an opportunity to consolidate and improve upon its position as the fifth most innovative country in the world (and second in innovation output). (Dutta, Lanvin, & Wuncsch-Vincent, 2014) In addition to closing the gap in some areas (mentioned above), the GRIDS can also continue to strength the Netherlands in these key areas:

- University / industry research collaboration (#11)
- State of cluster development (#8)
- Royalty & license fees payments, % total trade (#4)
- Knowledge & technology outputs (#9)
- Royalty & license fee receipts (#3)

Leverage the strength and diversity of the cluster

One of the unique selling points of the GRIDS educational program is its multi-disciplinary approach connecting business and society, engineering and entrepreneurship in one program. The MSc's in Eindhoven, Tilburg and 's-Hertogenbosch will complement each other, offering a unique flexibility to the students in the GRIDS programs. The GRIDS will be combine existing technical strengths of TU/e, as well as the business and societal perspective found at TiU. Although the MSc will differentiate itself from the other two by focusing on applied science rather than fundamental science, this focus will enhance the GRIDS offering as a whole.

A strong ecosystem based on multiple success factors

The GRIDS will be deeply embedded in the ecosystem. While established industries in and around North-Brabant are strong, the GRIDS has the potential to enhance existing industries and build a new one. As the GRIDS builds an ecosystem it should consider some of the following key success factors.

Access to capital, corporate backing (e.g. Brand Loyalty, Philips, ASML, etc.) and a diversity of industries can lead to greater success. Educational and cultural elements including knowledge renewal (e.g. knowledge transfer from person-to-person, company-to-company), talent access and attraction

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[4] Recent developments come from multiple sources found in the appendix and identified via the organization that wrote publication. This includes: Airbnb (only one), Deloitte (IoT Logistics White Paper – to be released on 15 September 2015), Forbes (only one), Microsoft (only one), MIT Technology Review (Harvesting Data Helps Grow Farm Yields), Philips (only one)

and entrepreneurial spirit can are also key building blocks. Different ecosystems have different strengths, in other words there is more than one formula for success. Since an ecosystem cannot be strong in all areas, the GRIDS will need to choose its focus based on current conditions.

Ecosystem success is increasingly linked to connections between entrepreneurs, support organizations and the larger organizations support the ecosystem. These inter-firm and inter-organization knowledge flows are even important in developing ecosystems. Although, there are several ways that knowledge can flow (or be transferred) in an ecosystem, there seems to be one critical, overarching observation – 'a sense of community'. As observed in the St. Louis ecosystem, it was the creation of a "community in which those [recipients] constantly observed the progress of the other recipient companies and provided each other feedback about their businesses". (Motoyama & Watkins, 2014)

This sense of community and the facilitation of knowledge transfer from organization to organization seems to be a common theme between successful ecosystems. Physical locations in Eindhoven, Tilburg, and 's-Hertogenbosch provide hubs for GRIDS to interact with the region. The different components of the initiative including the Data Science Centers (TU/e & TiU) and Graduate School Data Science Mariënburg also provide the mechanisms for knowledge exchange via research projects, workshops, business case competitions with students and other events.

Eindhoven and Tilburg already represent hubs of talent, albeit with different focal points. The establishment of Graduate School Data Science Mariënburg represents an opportunity to attract, develop and retain talent for the city of 's-Hertogenbosch. First year inflows at Graduate School Data Science Mariënburg are expected to be 60 students for the MSc – Entrepreneurship, PDEng program, and PhD combined with growth to 140 students per year in the steady state. Thus, in a steady state, the city of 's-Hertogenbosch can expect a student population of 212 additional data scientists.[5] The influx of students plus the history of the city and the industry in the region make it an attractive option for talent (and companies seeking talented data scientists).

Corporate backing represents an area where the ecosystem around the GRIDS is already strong. There are a number of large companies with the need for data science expertise headquartered or operating in the North-Brabant region. These organizations come from a broad range of industries including: Agro & Food, Automotive, Consumer Products, Finance, High-Tech, Insurance, Law, Manufacturing, Wellness and Wellbeing just to name a few. Below is a list of the largest companies present in North-Brabant along with their corporate revenues.

Table 6. Largest companies in North-Brabant (Overall Corporate Revenues - 2014) (Hoovers, 2014)

	Revenue (in millions USD)	Location
ArcelorMittal	*79.440.000*	*'s-Hertogenbosch*
Philips	*26.000.000*	*Eindhoven*
Sonac Son	*11.990.000*	*Son En Breugel*
Van Eerd Beheer	*7.888.000*	*Veghel*
Essent	*7.157.000*	*'s-Hertogenbosch*
ASML	*7.118.000*	*Veldhoven*
Jump Groep	*6.647.000*	*Veghel*
VION	*6.067.000*	*Boxtel*
NXP Semiconductors	*5.647.000*	*Eindhoven*
Nutreco	*5.340.000*	*Boxmeer*
A. Hak Electron	*4.962.000*	*Veghel*
Acer Europe	*4.817.000*	*'s-Hertogenbosch*
DAF Trucks	*4.774.000*	*Eindhoven*
EFR Europe	*4.421.000*	*Breda*
Lekkerland	*3.521.000*	*Son En Breugel*
Sligro Food	*3.439.000*	*Veghel*
VDL Groep	*2.846.000*	*Eindhoven*
Ricoh	*2.586.000*	*'s-Hertogenbosch*
Heijmans	*2.270.000*	*Rosmalen*
Athlon Car Lease	*1.921.000*	*Eindhoven*

* Companies in bold have been approached about supporting the GRIDS

Combining the differentiated strengths of each city; the initiative can draw on a diverse array of companies. Both in terms of their industries and themes of interest, as well as their operating geographies.

Over time, the ecosystem should evolve to become self-propelling around the GRIDS. The aforementioned success factors create the right conditions for the ecosystem to develop in such a

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[5] Current student population estimates requires validated with TU/e, TiU and appropriate regulatory bodies.

fashion. Towards this end, the GRIDS will need to successful translate the entrepreneurial capabilities of students and researchers at Graduate School Data Science Mariënburg into the culture of the wider ecosystem. Entrepreneurship – and more specifically, serial entrepreneurship is a key cultural phenomenon in successful ecosystems from Silicon Valley to Tel Aviv. (Startup Genome and Telefonica Digital, 2012) This culture could have a multiplying effect as it creates more potential mentors and coaches to guide early-stage companies.

Last, the GRIDS will need to encourage students, researchers and its companies to be bold. The more successful ecosystems are adaptive and even better, proactive in terms of adopting new technologies, business models and management processes. Being at the cutting-edge involves risk and lacks guarantees, but a higher risk tolerance creates opportunity for success.

3.3 Partnerships and alliances

The theme of innovation for the GRIDS should also run through the way that it interacts with the ecosystem. Collaborative effort between the universities involved in GRIDS should innovate and accelerate industry and society in the region, while strengthening the unique global position of the Province. The GRIDS consortium will be inventive in relationship development and maintenance with industry and society. Through the GRIDS, students will be able to connect with companies in the North-Brabant region and throughout the world.

With a strong knowledge valorization organization, the GRIDS should be able to compete for its share in the addressable market of data science. Calculations of the addressable market were based on the percentage of Analytics and Business Intelligence services as part of the overall ICT spent in the Netherlands (which amounted to €34 B in 2014). Aligning the overall share of theme spend indicates that the addressable market share amounts to €42 M. This number, however, does not take into account value-added data science services, which industrial partners would typically accommodate from their marketing or R&D budgets (spend). Therefore, the estimates provided below are considered conservative.

Table 7. Addressable market per theme and partners in the North-Brabant region by theme

Theme	Key candidate companies	Addressable market[6]
Bionic brains & amplified intelligence	AKD, Avans Hogeschool, BANNING, Boels Zanders, Boom, Brand Loyalty, CMS Derks, De Brauw, CBS, Deloitte, Blackstone, DeLex, Dirkzwager, Elsevier, Greenhouse Group, HAS, Houthoff Buruma, Jeroen Bosch Ziekenhuis, Kennedy Van der Laan, Koning Willem I College, Nauta Dutilh, RTL, Sdu, SlimmerLeven2020, Springtest, vanDoorne, Van Lanschot, Wolters Kluwer	€ 14 M
The connected wellbeing journey	Elisabeth Ziekenhuis, Jeroen Bosch Ziekenhuis, Lead Pharma, MSD Oss, Omron, Philips, SlimmerLeven2020, Tom, Toshiba Medical Systems Europe, Vitromics	€ 3 M
Data analytics of things	3D Hubs, Alfa Laval, ASML, Avular Drones, Bosch, Brabant Water, DAF, DAT.mobility, Eneco, enexis, Essent, Fokker, Heijmans, Honeywell, Huawei, KPN, Leapfrog, NXP, Omron, Ortec, Politie, Relatie World Class Maintenance, Ricoh, Rijkswaterstaat, Shapeways, Shell, Spark, Taskforce Logistics, TE Connectivity, Tesla, Thales, Tom, Toshiba Medical Systems Europe, Vanderlandse Industries, VECO	€ 1,8 M
Feeding the planet using data	AgroFood Capital, Apps for Agro, Bejo Zaden, DSM Food Science and Nutrition, Hendrix Genetics, Stark Marel Poultry Processing, NAFTC, Plantlab, Sligro Food Group, VION, ZLTO	€ 0,8 M
Data quest for the customer journey	AB InBev Nederland, Airbnb, Amazon, booking.com bol.com, Brand Loyalty, coolblue, Friesland Campina, Google, GoPro, Greenhouse Group, Heineken, Jumbo, kaggle, LinkedIn, Marktplaats, Mars Nederland, Netflix, P&G, Peerby, eCommerce, Soundcloud, Spinnin' Records, Spotify, Uber, Unilever	€ 2,4 M

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[6] Additional detail on addressable market can found in Appendix

Connecting the modern city	City of Eindhoven, City of Tilburg, City of 's-Hertogenbosch, Heijmans, Essent, KPN, Thalys, City of Amsterdam, City of the Hague, City of Rotterdam, Other EU regions	€ 20,2 M
Monetization of data	Achmea, Airbnb, Amazon, Bol.com, Booking, CZ, DeltaLloyd, Google, Interpolis, KLM, LinkedIn, Netflix, Spotify, TomTom	€ 0,3 M
Total		**€ 42 M**

Note: The table reflects the fair share of the addressable market and potential ecosystem partners. It does not indicate commitment by these partners. In addition, realization of these figures is dependent on the support and enablement resources being put into place. Additional calculations based on the current 'snapshot in time' can found in the Appendix: Onboarding Funnel. These calculations also reflect a percentage probability of the initiative realizing the full share of the addressable market. In many cases, the current probabilities remain low.

In observing and researching the success factors or other ecosystems, there are a number of lessons to keep in mind when developing a data science ecosystem around the GRIDS:

- Access to capital
- Human capital access and retention
- Entrepreneurial culture and serial entrepreneurship
- Topic focus and industrial flexibility

While human capital provides the foundation for a sustainable ecosystem, access to capital is the key to creating successful SMEs with the potential to grow into larger businesses. While the capital does not necessarily have to come from the locale (as with the Netherlands), having access to capital locally available makes it easier for start-ups and early-stage companies to network with investors. (Nederlandse Vereniging van Participatiemaatschappijen, 2014)

The non-financial factors focus more on the human element and the ecosystem's area of focus. As mentioned above, human capital is the basis for any ecosystem. Providing a steady flow of talented data scientists AND retaining them in and around North-Brabant is key. By retaining talent, the ecosystem will also begin to develop an entrepreneurial culture that will be enhanced by the focus on entrepreneurship in 's-Hertogenbosch. This culture paves the way for serial entrepreneurs and the much sought-after multiplier effect.

Finally, the GRIDS initiative seeks to build a data science ecosystem. This focus is unique among those taking a broader approach to building a broad-based ecosystem. That said, the applicability of the topic and practice of data science to a variety of industries provides the GRIDS with flexibility at the same time.

3.4 Constituent engagement – students, educational institutions, government, and the ecosystem

The GRIDS represents an exciting opportunity for all involved. While there are clear incentives to collaborate, it is critical that all parties find a structured way of working as the initiative moves into the implementation phases. Some of the governing principles of successful partnerships include (Deloitte, 2014):

- Strong leadership
- Clear strategy and scope
- Clear governance and decision-making
- Accounting for cultural differences
- Shared values
- Careful relationship management and mutual respect
- Clear legal and financial terms and conditions

To-date initial validation with select ecosystem partners has been conducted in June. Further validation of propositions may be required to sharpen offerings, themes and levels of commitment. Deloitte's experience in developing offerings was applied where appropriate.

Broad ecosystem engagement

Forming an ecosystem with the organizations requiring data science talent and solutions is critical. Key to managing it is developing a mutually beneficial, but self-propelling ecosystem that can sustain itself with limited recurring investment.

An ecosystem board can be developed to engage key GRIDS partners (Flagship and Premium partners, see Theme-based, micro-ecosystem engagement) across various themes / industries. The board will provide the GRIDS with insight into keys areas of focus in industry and society. Insight will then be used to align curriculum and research programs with current and future challenges as well as relevant trends and how they are impacting industry and society.

Theme-based, micro-ecosystem engagement

Given the diversity of partners involved in the initiative, it can also work with the ecosystem to form smaller micro-ecosystems that are more focused. Aligned with the themes of:

- Bionic Brains and Amplified Intelligence
- The Connected Wellbeing Journey
- Data Analytics of Things
- Feeding the Planet Using Data
- Data Quest for the Customer Journey
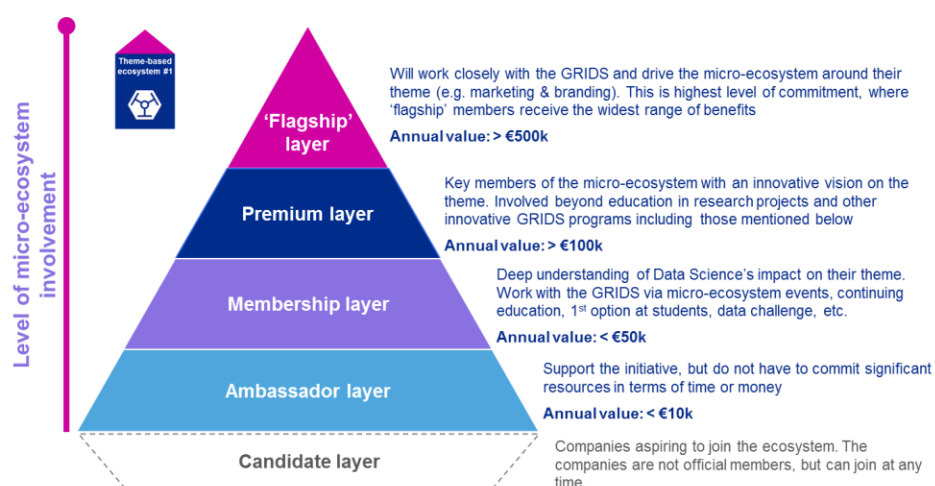- Connecting the Modern City
- Monetization of data

Figure 5. Levels of micro-ecosystem involvement

Different layers of partnership allow the opportunity for different service bundles. Partners who commit more funding to the GRIDS can expect to realize greater value than those who commit less to the initiative. Potential services that could be included in the bundles are the following:

- Internships.
- Collaborative data initiatives
- Temp program

Partners will have the ability to move up or down through the layers as they grow, based on needs or other circumstances. The GRIDS will provide each partner or potential partner with the ability to tailor their involvement based on the privileges most important to them (e.g. would they rather be involved to utilize the network, research programs or access to talent?).

Each micro-ecosystem will contain a key driver or a 'Flagship' partner, who maintain the highest level of commitment, but have access to the widest range of benefits. From this position they collaborate to drive Data Science research and development priorities related to the theme.

For example, Philips has a Flagship alliance with TU/e in the area of research. Philips came to TU/e with a strategic problem, the company had decided that it needed to undergo a complete business model overhaul, but lacked the human capital to carry out the transformation. In this partnership, Philips and TU/e are using 'living labs' – a user centered, open innovation ecosystem integrating

research and innovation processes – to create new data-driven business models in healthcare. (Flaman, 2015) The program includes 20 PhD participants from TU/e and is one of multiple research alliances that Philips has globally (one of the others being with MIT).

Premium members are key members who have an innovative vision on the theme. These organizations are deeply involved in the GRIDS (beyond education) through research projects as well the benefits mentioned below. The Membership layer contains organizations with a deep understanding of data science's impact on their theme. They will work with the GRIDS via micro-ecosystem events, continuing education and data challenges. These members will also have a first option on students from the GRIDS participants. At the Ambassador level, companies can support the initiative and benefit from the micro-ecosystem community, events, and research with a minimum level of commitment in terms of time or money. Finally, at the base of this structure is the Candidate layer, which includes companies who are not part of the initiative, but are welcome to join at any time.

Micro-ecosystems meet 1-2 times a year to discuss the impact of relevant Data Science trends on their business (or theme). For example in Feeding the Planet Using Data, this theme-based community could discuss ways to gather data from new or existing sources to reduce food waste or improve crop yields. These discussions can be used to re-orient the Graduate School Data Science Mariënburg and knowledge valorization organization's domain-specific programs.

4. Capabilities required for GRIDS to succeed

4.1 Distinctive capabilities

In order to deliver on value propositions for institutions and the ecosystems, GRIDS will require unique capabilities. It will provide a range of products and services (highlighted above) and possess capabilities that make it the go-to destination for data science in the Europe. The knowledge valorization organization will serve as an enabler for the data science ecosystem surrounding GRIDS, with four core roles:

1. *Ecosystem facilitator with front-office in 's-Hertogenbosch:* using a virtual operating model, the entity will maintain a small staff of personnel physically located at Graduate School Data Science Mariënburg with additional support coming from the existing capabilities of TU/e and TiU.
2. *Research-oriented and project-driven:* GRIDS will serve as a one-stop shop for the ecosystem's research needs in data science. Based on the request it will then coordinate research with appropriate competency (i.e. engineering in Eindhoven, business and society in Tilburg or entrepreneurship in 's-Hertogenbosch).
3. *True to the themes of research:* research programs and PhDs will be tailored to and focused in the domain of the partnering request research support (i.e. data quest for the customer journey in marketing & branding).
4. *Tight cooperation with industry and government (the Triple Helix):* the organization is designed to strengthen the links and valorization capabilities of education and research to both industry and government. Research performed with ecosystem partners will be both socially relevant and applicable to business and strengthen the Triple Helix.

There will also be business development and marketing capabilities to enhance the data science ecosystem in the region. Marketing resources, events, digital marketing and collateral will be developed either at Graduate School Data Science Mariënburg, TU/e or TiU.

4.2 Enabling organizational structure – GRIDS

The target operating and people model contains several levels. At the highest level, the ecosystem (GRIDS) is guided by and consists of the two autonomic entities (the Data Science Centers at Tilburg and Eindhoven). In addition, the Graduate School Data Science Mariënburg represents a new pillar for collaboration with partners on ecosystem and entrepreneurship initiatives.

In this section, we will describe the target operating model, which entails both the business model, the operating model and the people model for the GRIDS, including Graduate School Data Science Mariënburg.

Business model

Business model: customer segments	**Ecosystem partners:** • Large Dutch companies • Regional Dutch companies • Multinationals • Regional and local government • National governmental bodies • Start-ups and Exponential organizations • Industry and trade associations **Graduate School Data Science Mariënburg**: • High school students: Dutch VWO 3,4,5; EU, non EU

	• Undergraduates: Dutch, EU, non EU • Graduates: Dutch, EU, non EU • Professional: Dutch, EU, non EU

The customer segments contain two main categories. First is the ecosystem partners, who will be heavily involved in research and will also play a role in the educational program. Second, there are students for the educational offering. This segment consists of both national and international students, on undergrad, graduate and professional levels.

Business Model: channels	• Physical locations:
	   ○ Physical location of 's-Hertogenbosch for Graduate School Data Science Mariënburg
	   ○ Physical location of TU/e for DSC/e and the MSc Data Science & Engineering
	   ○ Physical location of TiU for DSCt and the MSc Data Science & Business and Society
	• Collaborative research networks (virtual)
	• Massive Open Online Courses / digital education (Learning Management Systems)
	• Advisory channels (face to face, phone, email)
	• Social media (LinkedIn, Facebook)

The delivery of services will be via different physical locations. The Joint Bachelor Data Science will be located both in Eindhoven and Tilburg, with the possibility to deliver courses in 's-Hertogenbosch. The proprietary Masters Data Science will be delivered at the respective universities and the Masters DS & Entrepreneurship will be housed in 's-Hertogenbosch. Part of the educational offerings can be offered via digital channel (i.e. MOOCs), especially for courses that are required to achieve the required entry level for a master's program.

Business model: products and services	**Research and Valorization in 's-Hertogenbosch, Eindhoven and Tilburg:** • Academic Publications • Joint Research • Contract Research • Joint PhD projects • Sponsored Chairs • Partnerships • Sponsorships and business development • Marketing • Technology transfer[7] **Specific products and services for the Graduate School Data Science Mariënburg** • Event services (onsite and online) **Education in the Graduate School Data Science Mariënburg:** • MSc Data Science Entrepreneurship • PhD Program Data Science • PDEng Data Science Program • Professional Development Courses • Executive Programs **Education in Eindhoven and Tilburg:** • Joint Bachelor Data Science • MSc Data Science Engineering (Eindhoven) • MSc Data Science Business & Society (Tilburg) • PDEng Data Science Engineering (Eindhoven) • PhD Program Data Science (Eindhoven) • PhD Program Data Science (Tilburg)

The traditional higher education products and services are delivered both in 's-Hertogenbosch and in Eindhoven and Tilburg (education, research, and valorization).

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[7] Assumption that Graduate School Data Science Mariënburg can leverage the technology transfer office at TU/e

People model

People model: performance management	• Key behavior for academics: open, enterprising, connecting, spotting opportunities. • Values: have a positive impact on society and business, hold ourselves to the highest standard, generate an excellent academic base, inspire the ecosystem to fuel innovation and chase big objectives. • KPIs, Appraisal: The 'normal' academic performance indicators for research (publications, citations, impact scores) and education (evaluations, courses) should be complemented to include performance on connecting to the ecosystem and entrepreneurial results. Policies on IP and inventions should reward this behavior.
People model: recruitment, development, deployment and retention	• Academic staff **recruitment**: to stimulate the key behaviors in 's-Hertogenbosch, recruitment will be a crucial step. The selection of current staff in Eindhoven and Tilburg should be executed carefully, in order to attract the right talent. A proven track record in entrepreneurship, or a broad network in industry should be important selection criteria. The Graduate School Data Science Mariënburg will offer great entrepreneurial possibilities and freedom, which can be leveraged in recruitment. • Academic staff **development**: PhD program should be structured to stimulate entrepreneurship. It could be consider to create new types of academic profiles, for example a start-up Postdoc, aimed at attracting entrepreneurial PhD's who will be supported with a start-up. (assistant, associate, full) Professors could be stimulated to undertake secondments in industry, or to attract talent from industry partners to secondments in academia. See Grants & Incentives for funding possibilities for industry cooperation. Academic staff (assistant professor and up) should play a pivotal role in the distribution of seed funding to students. • Academic staff **retention**: the people model should enable academic staff to (participate in) starting up a company. Sabbatical could be used to enable 'time off' for start-ups and spinoffs, but retain the staff in the longer term. • For an overview of the required FTE's and function names, please refer to the financial business case.

Operating model

Operating model: Structure and governance	**Structure Graduate School Data Science Mariënburg:**
	• Scientific Director's office
	• Graduate Program Director's office
	• Scientific Staff
	• Support Staff:
	• Education & Student Services
	• Research Support
	   o Marketing & Communication
	   o PDEng Program Management
	   o Policy Services
	   o General support (Location Service, Human Resources & Finance, Information Technology)
	
	Initial Governance Structure (2015 - to be decided 2016, e.g. 1-1-2016):
	• Bestuurlijk Overleg or Executive Steering Committee (TU/e, TiU, Province of North-Brabant, City of 's-Hertogenbosch)
	• Operational Steering Committee
	• Tilburg University for Accreditation
	• Ecosystem Advisory Council
	
	Permanent Governance Structure:
	• To be determined in subsequent phases
	
	Coordination Mechanisms:
	• Research Programming Board with TU/e and TiU
	• Education Programming Board with TU/e and TiU

Governance structure

The mode of governance for the GRIDS and Graduate School Data Science Mariënburg will be developed and refined in subsequent phases of this initiative.

Curatorium / Supervisory Board MSc Data Science & Entrepreneurship

The Supervisory Board is an oversight body to ensure the program's alignment with practice and its overall quality. The board consists of executives from ecosystem partners, and has representatives from at least one multinational, one large national, and public sector organization and one exponential/start-up. The members will be selected by the executive board.

Operating model: technology	Technology	Sourcing
	Netw ork (wired / w ireless)	Source
	Workstations / Laptops	Source
	Mobile devices	Source
	Telephones	Source
	Data storage (file storage, databases)	Source
	Secure file transfer facilities	Source
	(Access to) high performance computing	Source
	Information systems	
	Student Information System	Source
	Student portal	Source
	Learning Management System	Source
	Time Schedule System	Source
	Current Research Information System	Source
	Financial system	Source
	Customer Relationship Management system	Ow n
	Human Resources, payroll and talent system	Source
	Facilities management system	Source
	Data w arehouse / Reporting	Source
	Office automation	Source
	Public Website	Ow n

The processes for the Graduate School have been based on the business functions of the HORA (Hoger Onderwijs Referentie Architectuur). Per business function the sourcing of the function has to be decided. Some processes can follow best practices and be owned in 's-Hertogenbosch, or when these are not available, the process be copied from best-in-class from either university, or sourced via one of the universities. Own does not imply that the technology should be bought – it can be either bought, leased or sourced as a service. Parts of the technology could sponsored by ecosystem partners. This will be of the implementation phase and is out-of-scope for the initial ecosystem.

	Function group	Business function	Sourcing
Operating Model: Processes and Information	Governance	Strategy and governance	Own
		Policy and planning	Own
		Change management	Own
		Improvement management	Own
		Accountability	Own
	Education	Curriculum development	Own
		Curriculum execution	Own
		Tutoring	Own
		Examination	Own
	Research	Research development	Own
		Research design	Own
		Research execution	Own
		Research publication	Own
	Valorization	Know ledge utilization	Own
	Education support	Student recruitment	Own
		Student enrollment	Own
		Education planning	Own
		Time scheduling	Own
		Student counseling	Own
		Certification	Source
	Research support	Research administration	Own
		Research support	Own
	Information supply	Information supply	Source
		Information throughput	Source
	Business	Human Resources	Source
		Finance	Source
		Facilities	Own
		Information Technology	Source
		Procurement	Source
		Customer Relationship Management	Own
		Communication	Own
		Legal	Source

Operating model: Location(s)	**Location Mariënburg, 's-Hertogenbosch** • Graduate School Data Science Mariënburg **Location TU/e, Eindhoven** • DSC/e **Location TiU, Tilburg** • DSCt

5. GRIDS priority initiatives and investments

5.1 Initiative roadmap

For the structured implementation of the GRIDS and a knowledge valorization organization, two roadmaps have been developed in order to take the next steps towards success. The roadmaps provide a phased approach to the capability building required to implement the GRIDS. The implementation will comprise of three phases that include:
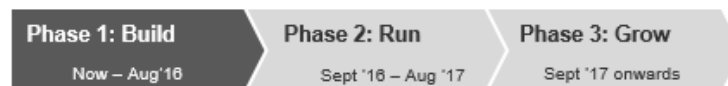
The roadmap differentiates the various organizational pillars involved:

- Structure & Governance
- Processes & Information
- Technology
- Talent
- Marketing, Communication & Branding
- Products & Services

The first phase for the GRIDS has been elaborated in detail in Figure 6.
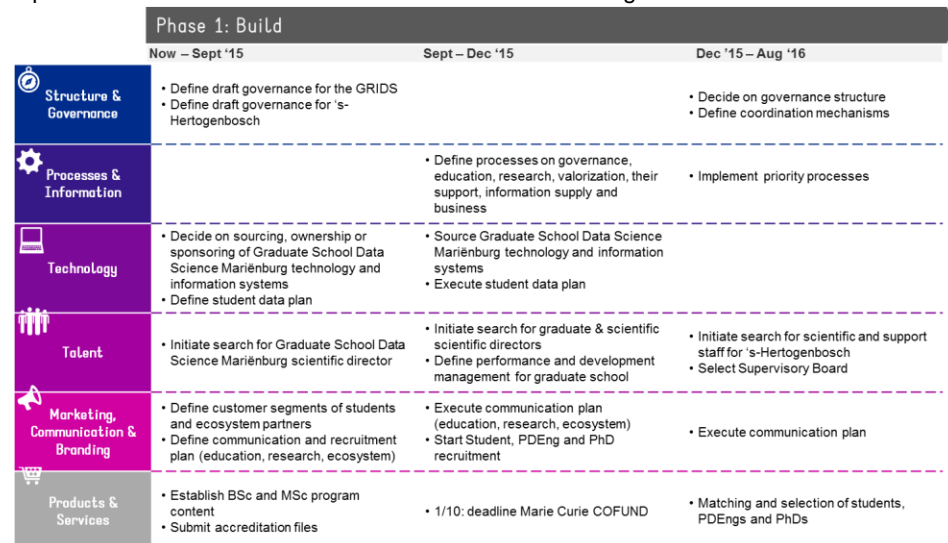

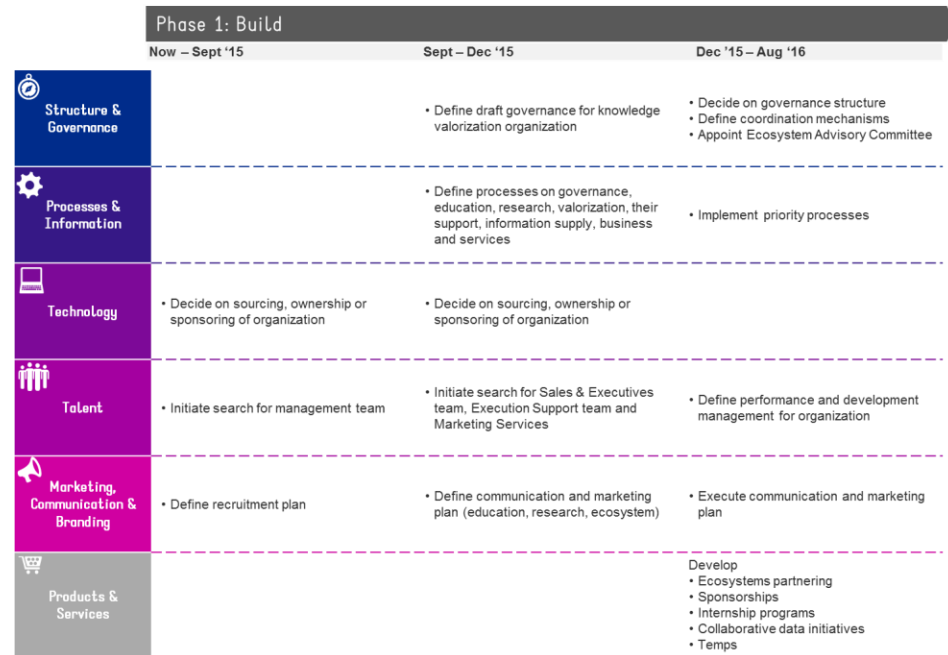*Figure 6. Detailed roadmap of phase 1 – Build – for the GRIDS*

Phase 1: Build		
	Now – Sept '15	Sept – Dec '15	Dec '15 – Aug '16

Structure & Governance
- Define draft governance for knowledge valorization organization
- Decide on governance structure
- Define coordination mechanisms
- Appoint Ecosystem Advisory Committee

Processes & Information
- Define processes on governance, education, research, valorization, their support, information supply, business and services
- Implement priority processes

Technology
- Decide on sourcing, ownership or sponsoring of organization
- Decide on sourcing, ownership or sponsoring of organization

Talent
- Initiate search for management team
- Initiate search for Sales & Executives team, Execution Support team and Marketing Services
- Define performance and development management for organization

Marketing, Communication & Branding
- Define recruitment plan
- Define communication and marketing plan (education, research, ecosystem)
- Execute communication and marketing plan

Products & Services
- Develop
  - Ecosystems partnering
  - Sponsorships
  - Internship programs
  - Collaborative data initiatives
  - Temps

Figure 7. Detailed roadmap of phase 1 – Build – for the knowledge valorization organization

5.2 Creating and sustaining excellence

The end goal for the GRIDS is establish an integrated ecosystem amongst Triple Helix stakeholders in and around North-Brabant. It is designed with open innovation and collaboration as its core attributes. Through project-based research with ecosystem partners, GRIDS will link with North-Brabant and European-level priorities and research with the region realizing benefits in the form of job creation and new, data-driven business models for businesses and organizations.

As previously mentioned, Graduate School Data Science Mariënburg will act as a front-office for marketing & branding for the data science ecosystem and business development support for the research programs. In the future, it could function as a hybrid incubator / accelerator for entrepreneurship / starts-ups, while delivering a wide-range of project-based services to partners. The GRIDS can also seek extend its ecosystem abroad to developing collaborative relationships with international partners (e.g. Cambridge Innovation Center, etc.)

The first wave of products and services for the knowledge valorization organization has already been defined. In order to grow and create a self-propelling ecosystem, two additional waves of services are recommended. These services could be built-up internally or, in specific areas, sourced via a third-party provider depending on the function and expertise required to carry out the service. The relationships GRIDS has with its ecosystem partners and its ability to build on the knowledge valorization organization will evolve over time, thus services could be offered incrementally.

Additional potential services

- *Subscription-based data services* – For repetitive solutions and services, ecosystem partners can benefit through a subscription model. For example, monthly or annually run reports and surveys, trends analysis, etc. are good initial candidates for this offering.
- *Product-based selling / licensing* – Intellectual properly previously developed as part of the project-based work with the ecosystem partners may result in generic or industry data solutions. Such solutions may be sold under IP license or converted into software products. Candidates for such offering would be medical informatics health risk indicators, methods / tools for processing large data sets, etc.
- *Start-up funding – type 2 (spin-out / exits)* – On its own and in cooperation with its theme-based partners, the knowledge valorization organization can assist companies within its hybrid enabler to connect with other companies interested in acquisition of the company or specific IP (include a success fee).
- *Investment advisory* – The knowledge valorization organization could develop the capability, or work with its ecosystem partners to offer technical and / or business advice to investors (of

various types) interested in data science-related investment. This type of work can be co-sourced with ecosystem partners to reduce upfront investment levels.

- *Back-office support* – The knowledge valorization organization could assist early-stage companies via its ecosystem partners, including those in its hybrid enabler with non-core business support (HR, Finance, IT, etc.). This could include a discount and / or a cut of the fee. This type of work can be co-sourced with ecosystem partners to reduce upfront investment.
- *Data science certification* – No certification program exists in the area of data science. The knowledge valorization organization could work with ecosystem partners to develop the courses and standards for a cross-industry certification. Costs could be recouped via donations from partners and fees could be charged to those taking the certification course.
- *Partner identification* – Via an ecosystem partner, the knowledge valorization organization can connect students, faculty, or companies with relevant – either based on themes or IP – companies or organizations to form consortia. This could include a discount and / or a cut of the fee). This type of work can be co-sourced with partners to reduce investment levels.
- *Legal & IP* – Via an ecosystem partner, the knowledge valorization organization could support companies and researchers with both IP-related and business start-up-related legal services. Again, the valorization organization could receive a cut of the fee and obtain the service for the interested party at a discount. This service can be co-sourced with partners to reduce investment.
- *Grants & incentives* – The knowledge valorization organization could build a team of experts or utilize an external provider (at a discount and / or take a percentage of the fee) to assist faculty and students with obtaining grants or incentives for research. Additionally, this group can assist faculty and students to connect with consortia to unlock a different set of grants and incentives (e.g. Horizon 2020). This can be co-sourced with ecosystem partners to reduce upfront investment levels.

6. Conclusions and recommendations

6.1 Conclusions

In light of the current and projected need for data science talent, the vision of a cluster around data science is timely, bold and promising. With the right mechanisms the GRIDS is well positioned to succeed and provide a good return on investment for the € 40 M invested by the stakeholders due to Triple Helix collaboration and well-established institutions supporting it.

The proposition has unique features that combine the strengths of the involved stakeholders. The educational vision (creating 't-shaped' data scientists), which is based the combination of on an interdisciplinary approach and solving real world challenges, leverages and capitalizes on the existing 'knowledge infrastructure' as well as the ecosystem. The research vision, that is highly relevant and connected to society and industry through modular themes of focus. It lays a solid foundation for deep ecosystem embeddedness. The expansion to the city of 's Hertogenbosch adds three new aspects to the proposition. Firstly, it creates a geographical advantage, due to the favorable position relative to other hubs in the Netherlands. Secondly, it enhances the proposition with the focus on entrepreneurship. Lastly, it creates an appealing front-office for entrepreneurial activity and industry interaction.

Upon establishment, the GRIDS can reinforce North-Brabant as an innovative environment by providing the data science talent for the future, increasing the attractiveness for human capital and companies alike, and create job opportunities due to the increase in entrepreneurial activity. To achieve these advantages and the desired scale, the initiative will need to secure the first-mover advantage on the competition. Other initiatives around data science are being formed, therefore the window of opportunity is short. The operation needs to be established swiftly and professionally. The current plans form a solid basis, but require decisive execution. The Triple Helix collaboration is needed throughout, in order to establish and maintain the unique selling points of GRIDS. The secure future success, follow through on the ambitions and the design is essential, in order to become truly embedded in the ecosystem of the region and thus achieve the goals of GRIDS.

6.2 Recommendations

1. **Act fast:** the initiative is timely, but time is of the essence. Competition exists, but largely lack the unique features of GRIDS (i.e. the ecosystem embeddedness and multi-disciplinary data scientist). Gaining a fair market share will be noticeably harder once other initiatives take shape.

2. **Be international from day one:** the initiative and Graduate School Data Science Mariënburg should think and act globally from the outset. To compete with the best, this philosophy should apply to student recruitment, as well as the recruitment of faculty with international experience and exposure. Complementing Dutch with English as the core language of communication can also prepare GRIDS data scientists to work with multinational businesses.

3. **Establish a knowledge valorization organization:** in order to facilitate the ecosystem interactions, a knowledge valorization organization should be established. Eventually, this organization should serve two important purposes. First is that of a traditional incubator and that of an accelerator (see recommendation 3). The secondary and high value-added role of the organization is to provide ecosystem products and services creating value for the data science ecosystem. This role is a true differentiating capability that goes above and beyond the majority of incubators and accelerators. The combination of these roles will drive entrepreneurial activity and help create a self-propelling ecosystem. The organization could

also play a pivotal role in the onboarding of new ecosystem partners. It our experience this is a critical function in the establishment and maintenance of an ecosystem.

4. **Develop a hybrid enabler:** developing a hybrid enabler provides the opportunity to create new business models, solutions and companies; as well as enrich the SME-community in the North-Brabant region. As with most incubators, the hybrid enabler will be a physical space attached to a knowledge center (Graduate School Data Entrepreneurship Mariënburg). It will help valorize its own spin-outs. It should also feature elements of an accelerator, which include the option for a pre-seed investment in exchange for a minority stake in a start-up.

5. **Provide start-up funding:** the ambition for the Graduate School Data Entrepreneurship Mariënburg is become the epicenter of startups and entrepreneurship for the region. In order to help startups succeed, access to startup funding is a critical success factor.

6. **Further detailing on ecosystem/themes:** the modular themes of focus lay the groundwork for the embedded research and the ecosystem setup. To establish the envisioned micro-ecosystems, further detailing is required. Close corporation between academics and the targeted ecosystem partners is recommended.

7. **Specify IT infrastructure investments:** the business case for the Graduate School Data Entrepreneurship Mariënburg was not specific for the investments in the IT infrastructure. Since this plays an important role in data science, it is our recommendation to further specify the expected investments.

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	Organization
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Jan Buitink	City of 's-Hertogenbosch
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Maurice Groten	Eindhoven University of Technology
Patrick Groothuis	Eindhoven University of Technology
Dick den Hartog	Tilburg University
Edwin van den Heuvel	Eindhoven University of Technology
Willem-Jan van den Heuvel	Tilburg University
Arno van der Hurk	Province of North-Brabant
Ruben Kolfschoten	Brabantse Ontwikkelings Maatschappij
Frederique Knoet	Tilburg University
Irene Lammers	Province North-Brabant
Johan van Leeuwarden	Eindhoven University of Technology
Eric Logister	City of 's-Hertogenbosch
Max Louwerse	Tilburg University
Will van der Made	City of 's-Hertogenbosch
Lex Meijdam	Tilburg University
Jan Mengelers	Technical University of Eindhoven
Erik van Merrienboer	Province North-Brabant
Bert Pauli	Province North-Brabant
Corien Prins	Tilburg University
Angelique Penners-Wouters	Tilburg University
Isabelle Reymen	Eindhoven University of Technology
Ton Rombouts	City of 's-Hertogenbosch
Henri Swinkels	Province North-Brabant
Wybe Thijsse	Province North-Brabant
Loet Visschers	Province North-Brabant

Appendix

Strengths, Weaknesses, Opportunities, Threats (SWOT)

Strengths	Weaknesses
• Multi-disciplinary educational approach • Blend of fundamental and applied research available between the three institutions • Embeddedness of the initiative in the ecosystem and alignment with regional objectives • Presence of strong corporates in the region to support and propel the data science ecosystem • Relevance of education and research programs to industry and society	• Low barrier to entry for potential competition • Ranking and reputation of the GRIDS institutions versus international competition (Harvard, Stanford, etc.) • May impact ability to attract students, faculty, researchers, etc. • No clear flagship identified in certain themes • Access to capital in the region for early-stage companies
Opportunities	**Threats**
• Become the first-mover in the Data Science education and research market in the Netherlands • Unique approach to education and research ('T-Shaped') • Develop unique relationships with ecosystem organizations through unique research programs – PDEng, collaborative data initiatives, etc. • Provide knowledge valorization services	• Data science is a trendy topic generating interest from educational institutions globally • Complexity of stakeholder and ecosystem management • Corporate commitment to taking lead role in propelling the ecosystem • Corporate funding to sponsor research programs in all themes • Equal viability and interest in all themes

Competitive Benchmarking

Peer institution comparison

To define the benchmark institutions criteria were used for the selection. These criteria were defined based on the characteristics of the Graduate School Data Science Mariënburg.

A first selection of universities was made by selecting only universities with a good (international) reputation that offer a track in Data Science or Analytics. A further comparison was made based on the following criteria:

1. Does the Master have either a multidisciplinary or entrepreneurship focus?
2. Is the Master embedded in an ecosystem?
3. Does it offer a Bachelors program on data science prior to the Master?

Table 1 gives a short summary of the comparison of the institutions. A detailed description of the programs that these schools offer can be found below.

Table 1. Peer institutions

University		Master track	Reputation	Interdisciplinary Approach	Focus on Entrepreneurship	Connection with the business
Europe	Den Bosch	Graduate School Data Science	TiU ○ TUe ◑	✓	✓	TBD
	ETH Zurich	Statistics, Data Science track	◕			
	KU Leuven	Artificial Intelligence, Big Data Analysis program	◑			
	TU Berlin	Data Analytics	○	✓		
	University of Edinburgh	High performance computing and data science	◑			Via guest lectures
	University of Southampton	Data Science	◔			
USA	Harvard	Computational Science & Engineering	●			Via projects / electives
	Stanford	Data Science	●			
	NYU Stern	Business Analytics	◑			
	Columbia University	Data Science	◕	✓	✓	Via ecosystem

* Reputation is considered high when the university is part of the top 50 of the Times Higher Education World University Rankings 2014-2015

Legend

● Top 10
◕ 11-25
◑ 26 - 100
◔ 100 - 200
○ 200 - 300

European universities

ETH Zurich

ETH has a Data Science track as part of their Statistics Master. The diploma requires in total 90 credit points: 60 credits from core courses and elective courses from both statistics/mathematics and a field of application and 30 credits from the Master thesis. The master is not multidisciplinary (only analytics courses) nor entrepreneurial or linked with the business. After graduation of the master it is possible to continue with a PhD in Statistics.

KU Leuven

At the KU Leuven students can follow a one-year program on Big Data Analysis as part of the Master Artificial Intelligence. The courses are focused only on the art of data analysis techniques, programming techniques and applications that deal with very large data collections. It instructs students on the central concepts of statistical data analysis, machine learning and data mining. It trains students to program learning and data mining techniques that need to cope with big data collections. It conducts deeper studies into a number of applications regarding big data and advanced analysis techniques.

Technische Universität Berlin

The track Data Analytics in the two-year MSc Information Systems Management contains 18-24 EC of data analytics courses. Students gain in-depth knowledge of either information systems or Economics for ICT. They also follow modules on Economics and Management. This program is setup by the Faculty of Electrical Engineering and Computer Science in cooperation with the School of Economics and Management. The close collaboration of the two faculties supports the interdisciplinary orientation of the master's program. The university offers a BSc program on Wirtschaftsinformatik (Economic Computer Science).

University of Edinburgh

The University of Edinburgh offers a one-year MSc in High Performance Computing and Data Science. The MSc in High Performance Computing with Data Science will provide students a thorough grounding in HPC technologies together with a practical

understanding of the key ideas and techniques of data science and the HPC tools that underpin them. The Master is very much focused on analytical courses and not on any multidisciplinary skills. The university connects with the business through guest lectures.

University of Southampton

At the University of Southampton students can follow the one-year Master in Data Science. Courses are purely focused on data science, no multidisciplinary or entrepreneurial aspects are included. This is typically linked to a number of core areas of expertise, from the ability to operate high-performance computing clusters and cloud-based infrastructures, to the know-how that is required to devise and apply sophisticated Big Data analytics techniques, and the creativity involved in designing powerful visualizations.

US universities

Harvard

Harvard offers a one-year Master of Science and a Master of Engineering in Computational Science & Engineering (CSE). The Masters provide rigorous training in the mathematical and computing foundations of CSE. Students will have opportunities to keep up with leading-edge work in CSE through projects and activities involving external partners. The Master of Engineering is more focused on research. As part of the program student do a capstone project and follow a seminar course, applying theoretical knowledge in practice. Harvard also has the possibility to do a PhD in Computational and Data Science.

Stanford

The Data Science track at Stanford as part of the Master of Science program aims to develop strong mathematical, statistical, and computational and programming skills. All courses are focused on developing data science skills with a mathematical basis. As part of the program students have the opportunity to participate in Data Science lab or capstone projects. Stanford also has a research group focused on Data Science: the Stanford Data Science Initiative (SDSI), a university-wide organization focused on core data technologies with strong ties to application areas across campus.

New York University Stern

The Master Business Analytics is the intersection of business and technology, offering new opportunities for a competitive advantage. Business analytics unlocks the predictive potential of data analysis to improve financial performance, strategic management, and operational efficiency. Courses have a business perspective aiming to transform data into a powerful and predictive strategic asset, e.g. revenue management and pricing. The university has a collaboration with NYU Shanghai, Erasmus University Rotterdam and the Chinese Ministry of Education.

MIT

MIT does not have a Master program defined specifically on Data Science. They do have a lot of knowledge on the topic as they have two research institutes focused on Big Data (CSAIL and EECS) and separate online courses on the topic.

Colombia University

As part of their Master Data Science students can choose for an Entrepreneurship track. Also they can choose electives in another competency, e.g. Financial and Business Analytics, Ethics and Sustainable Technology. Data Science Institute students are given the opportunity to conduct research opportunities included in a capstone project course, as well as industry interaction. After students have completed their master program Colombia University also offers PhDs in Data Science.

Ecosystem comparison

To achieve its ambition GRIDS must think globally, meaning it must understand the success factors for other start-up ecosystems around the world. While Silicon Valley remains the gold standard, the conditions there are unique and difficult to replicate elsewhere. As a number of other global ecosystems have shown, it is possible to create successful ecosystems in a variety of conditions.

Region	Ecosystem	Country	Key attributes
	Silicon Valley (CA)	US	• Unparalleled access to funding • Access to both local and global talent, including serial entrepreneurs

North America			• Balance of large corporations, mature start-ups, and early-stage companies
	Boston (MA)	US	• High start-up diversity – biomed, energy, data, etc. • Presence of world-renowned universities (Harvard, MIT) • High post-graduation talent retention due to opportunities
Europe, Middle East & Africa	Munich	DE	• Large technical organizations (TU Munich, BMW, Infineon) • Adequate access to funding – Siemens Venture Capital • Healthy start-up diversity – biomed, energy, data, etc.
	London	UK	• Biggest start-up system, financial hub in Europe • First place foreign start-ups establish as EMEA HQ • Access to talent, with incubators at Cambridge, Oxford
	Leuven	BE	• KU Leuven is a hub of start-up and technology transfer • Healthy start-up diversity – biomed, energy, data, etc. • Comparable to Den Bosch in size
	Tel Aviv	IL	• Highest density of technology start-ups in the world • Home to 88 NASDAQ-listed companies • Second highest output of start-ups behind Silicon Valley
Asia & Pacific	Melbourne	AU	• Particular focus on data from Melbourne-based start-ups • Ranked 3rd as a trendsetter in the *2012 Start-up Ecosystem* report

In observing and researching the success factors or other ecosystems, there are a number of lessons to keep in mind when developing a data science ecosystem around the GRIDS:

- Access to capital
- Human capital access and retention
- Entrepreneurial culture and serial entrepreneurship
- Topic focus and industrial flexibility

While human capital provides the foundation for a sustainable ecosystem, access to capital is the key to creating successful SMEs with the potential to grow into larger businesses. While the capital does not necessarily have to come from the locale (as with the Netherlands), having access to capital locally available makes it easier for start-ups and early-stage companies to network with investors. (Nederlandse Vereniging van Participatiemaatschappijen, 2014)

The non-financial factors focus more on the human element and the ecosystem's area of focus. As mentioned above, human capital is the basis for any ecosystem. Providing a steady flow of talented data scientists AND retaining them in and around North-Brabant is key. By retaining talent, the ecosystem will also begin to develop an entrepreneurial culture that will be enhanced by the focus on entrepreneurship in 's-Hertogenbosch. This culture paves the way for serial entrepreneurs and the much sought-after multiplier effect.

Finally, the GRIDS seeks to build a data science ecosystem. This focus is unique among those taking a broader approach to building a broad-based ecosystem. That said, the applicability of the topic and practice of data science to a variety of industries provides GRIDS with flexibility at the same time.

Onboarding Funnel

Introduction

The global ICT spend in 2015 is planned to reach $3,5 trillion which is a decline of 5% from the record breaking 2014 spend. The distribution of the ICT spends are divided into the following six categories:

Table 2. Gartner Study April 2015 - Worldwide IT Spending Forecast (Billions of U.S. Dollars)

	2015 Spending	2015 % of total
Devices	685	18%
Data Center Systems	142	5%
Enterprise Software	320	9%
IT Services*	**942**	**25%**
Telecom Services	1.572	43%

Overall IT   3.662

Following the specific request (2 July 2015) from the city of 's-Hertogenbosch to provide a high level ROI calculation for the Graduate School Data Science Mariënburg in 's-Hertogenbosch; we have used the aforementioned data regarding IT services as an indicative calculation of the so-called "addressable market". In the Netherlands, the ICT spend is approximately €34 B. €5,8 B of this is IT Services related – the domain in which data science / analytics is primarily categorized.

Table 3. ICT-MarktMonitor Study 2014 – Dutch IT Spending (Millions of Euro)

	2015 Spending	2015 % of total
Telco services	14.184	41%
Software	6.353	19%
Hardware	5.739	17%
IT Services*	**5.835**	**17%**
Networking equipment	2.187	6%
Overall IT	**34.298**	

At Graduate School Data Science Mariënburg in the initial years, we only calculate potential revenue based on organizations with operations in the Netherlands. To determine the Analytics / Business intelligence "fair share" of these budgets, a further segmentation is performed into the following categories (YTD Technology Consulting distribution Deloitte – July 2015)

Table 4. Deloitte Distribution ICT spend including percentage related to Business Intelligence and Data Analytics

	2015 % of total
ERP software apps	26%
CRM (salesforce.com, etc.)	11%
Enterprise architecture	11%
BI & Data Analytics	**14%**
Program leadership	9%
Deloitte Digital	17%
IT strategy	11%
Others	1%

As Business Intelligence and Data Analytics represents 14% of Deloitte Distribution ICT Spend, the determination is that €816 M is the addressable market for GRIDS.

Currently (YTD 06 July 2015), our estimation is that approximately €2,72 M of revenue is committed to by potential ecosystem partners based on the probability percentages shown in the spreadsheet attached. Per theme, this breaks down to the following:

Table 5. Deloitte Analysis of Estimated Fair Share and Progress in Sales Funnel (by theme)*

GRID themes	Estimated fair share	Identified Prob. 5%	Contacted Prob. 10%	Qualified Prob. 25%	Proposed Prob. 50%	Weighted total
1. The connected wellness journey (Personal care & wellbeing)	€ 3.000.000	€ 81.000	€ 93.000	€ 0	€ 0	€ 174.000
2. Feeding the planet using data (Agro, food, & nutrition)	€ 760.000	€ 36.000	€ 5.000	€ 0	€ 0	€ 40.000

3. Monetization of Data (Data entrepreneurship and value)	€ 300.00	€ 9.000	€ 7.000	€ 4.000	€ 0	€ 20.000
4. Bionic Brains & amplified intelligence	€ 14.000.000	€ 447.000	€ 510.000	€ 0	€ 0	€ 957.000
5. Data analytics of things (productivity & maintenance)	€ 2.000.000	€ 54.000	€ 75.000	€ 0	€ 0	€ 129.000
6. Data quest for the customer journey (marketing & branding)	€ 2.000.000	€ 78.000	€ 22.000	€ 145.000	€ 0	€ 246.000
7. Connecting the modern city (city mgmt.. & control)	€ 20.000.000	€ 864.000	€ 288.000	€ 0	€ 0	€ 1.152.000
Total conservative revenue projection	**€ 42.000.000**	**€ 1.569.000**	**€ 1.000.000**	**€ 149.00**	**€ 0**	**€ 2.718.000**

* Please see Table 6 for this information by partner. The acronym *Prob.* Is short for probability.

The estimated fair share of the wallet has been determined to be about €42,5 M if all parties are 100% committed. Given current progress in the onboarding funnel, the ROI of the anticipated Year One €7 M investment by the Province of North-Brabant will see a return of approximately €0,888 M based on a share of the wallet calculation. The labor market impact of these operations in Year One on the labor market in 's-Hertogenbosch will be negligible.

Assumptions and influencing aspects

In order to target the €42,5 M potential it is assumed, that the following will be required:

- Basic ICT costs and infrastructure that are not fully accounted for the business case by TU/e and TiU
- Establishment of a state-of-the-art data lab and hybrid ecosystem enabler
- Program coordination office
- Sales and business development team
- Ecosystem marketing team along with budget for associated materials, resources, etc.
- Data processing, cleaning and structuring budget
- Event facilitation budget
- Repetitive solutions that allow faster growth compared to the share of wallet in Year One of Graduate School Data Science Mariënburg

An estimation of the potential level of commitment of key players for the graduate school in financial terms. The request was to do so for each of the seven themes (those which were presented in the Executive Committee meeting of 1 July, supplemented by a seventh focus theme called Connecting the Modern City – smart cities) and to provide an overview / summary.

Grants, incentives details

At the EU, national and regional level many relevant grants and incentives exist, that can help fund and form the Graduate School. Many of these grants support international mobility and cooperation with industry, two important goals for the cluster initiative. Grants are financial instruments that stimulate organizations in achieving goals that are desirable for society and business.

There are three main investing elements that are eligible for receiving grants (see Figure 1):

1. **Innovation**: Development of new technologies, processes or knowledge
2. **Assets**: Investing in company assets such as facilities and production equipment
3. **HR-related**: Improving working conditions and facilitate learning programs

Overarching elements that influence the grant possibilities are the geographic focus, collaboration with partners and sustainability aspects.

Figure 1. Investing elements for receiving grants

A range of funding instruments are available for the project life cycle: from investments in facilities and **setting up the graduate school** concept to the funding of **exploitation of the institute** (e.g. exchange of students, collaboration with industry, research & development). The opportunities listed below are examples and do not represent an exhaustive list. Programs change over time and calls are published constantly.

Name	Description	Phase	Level	Max. funding (€)
JTI ECSL	Grants for projects which aims to design, manufacture and use the most innovative technologies in electronic components and systems, enabling to master 'smart everything'.	Exploitation	Europe	70% to 100% of costs
H2020: Marie Curie	Support for research training and career development focused on innovation skills. The program funds international and cross-sector mobility that implements excellent research in any field (a "bottom-up" approach).	Exploitation	Europe	100% of costs
H2020: Marie Curie COFUND	Fellowship programs fund individual research training and career development fellowships for experienced researchers. The programs supported should have regular selection rounds following fixed deadlines or regular cut-off dates, allowing fair competition between the researchers applying. On top of transnational mobility, applicants are encouraged to include elements of cross-sectorial mobility into their programs.	Set up	Europe	100% of costs
Erasmus+	Support for mobility of university staff and students. Additionally, funding for establishing international partnerships aiming to share best practices, know-how and stimulate innovation.	Set up	Europe	Depending on activity
H2020: LEIT	LEIT aims at collaborative projects regarding new and breakthrough technologies in the fields of ICT, nano, advanced materials, biotech and space.	Exploitation	Europe	70% to 100% of costs

H2020: Societal Challenges	This part of H2020 funds collaborative research, development and innovation projects that addresses major concerns shared by citizens in Europe and elsewhere. (Big) data forms an integral part of all these challenges.	Exploitation	Europe	70% to 100% of costs
ITEA3	ITEA stimulates collaborative R&D projects of large industry, SMEs, universities, research institutes and user organizations in the area of Software-intensive Systems & Services (SiSS).	Exploitation	Europe	Up to 50% of costs
TKI HTSM	The TKI stimulates the collaboration of public private partnerships. Active participation in the TKI HTSM, gives the opportunity to co-design the HTSM innovation roadmap.	Set up & exploitation	National	50% of costs, no maximum
MIT HTSM	Grant for collaborative innovation projects, together with SME's	Exploitation	National	35% of costs up to € 200.000
INTERREG NWE	Support for transnational actions that strengthen (cross-sectorial) innovation capacity in the NEW region. Also innovation projects tackling a social need.	Set up & exploitation	Region	Up to 60% of qualifying costs
OP Zuid	Grant for regional development project promoting collaboration in the triple helix and strengthening the innovation ecosystem (for SME's).	Set up & exploitation	Region	25%-35% of costs up to € 750.000

Grants require a rigorous approach to ensure competition and successful completion. Deloitte recommends the following grants and incentives process.
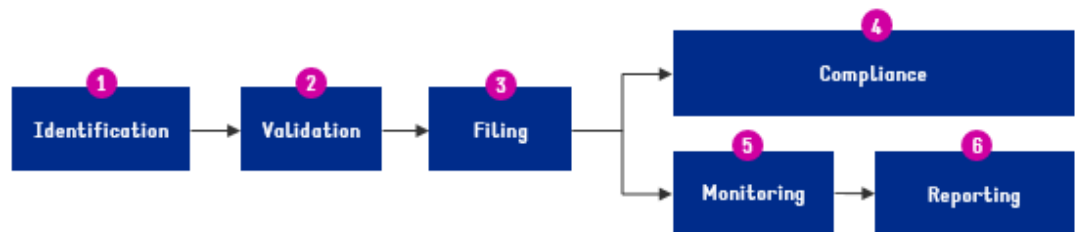
1. Identification of investment or projects that might qualify for grants or incentives (innovation, investment, HR, etc.). Organizational goals and strategy are leading. The short term as well as the long term strategy are taken into account.
2. Elements identified in phase 1 will be further assessed to determine if specific grant requirements can be met. This includes a cost/benefit analysis.
3. Drafting of the grant applications, including cost calculations, and budgeting.
4. Setting up an adequate administration for grants obtained. Existing internal processes should be followed as much as possible.
5. Monitor grant project progress from an accounting point of view. Reporting to grant authorities when necessary.

Common pitfalls in grants and incentive management are poor identification of grants, resulting in missed opportunities; lack of overview on grant call deadlines (in many cases only open once a year for a short period of time); insufficient knowledge of eligible costs for certain schemes; and not having managed the realization of eligible costs.

PR & Communication Strategy

Moving forward, it is critical that the Graduate School Data Science Mariënburg properly markets and positions itself vis-à-vis other ecosystems and universities. Across each pillar (education, research, and ecosystem) there will certainly be common threads such as the level of ambition and the vision of the new school. Though these overarching messages will still apply, there will also be nuanced positioning for various key stakeholders. For example, the correct positioning for to be attracted students will be very different than that of an innovative, data-enabled organization. A branding strategy defines to whom, what, when, and how to communicate to each audience.

Key stakeholders

First of all the critical stakeholders need to be defined. A distinction can be made between internal stakeholders, which are involved in developing the GRIDS, and external stakeholders, those which are required to successfully launch the GRIDS. The key stakeholders are:

- **TU/e and TiU** – both universities are the drivers from an education and research point of view for the GRIDS
  - o **Executive Boards (**College van Bestuur) – the Boards will make the final decision on approving the collaboration with the GRIDS
  - o **Deans and professors –** the deans will be heavily involved in developing the educational and research program; also they might take part at the GRIDS as e.g. teacher
  - o **Current researchers** – the current researchers at the TU/e and TiU would like to be informed on the progress and plans of the GRIDS and the implications for them
- **Province North-Brabant** – sponsor and supporter of the GRIDS and enabler of the ecosystem through its contacts with businesses in the region
- **City of 's-Hertogenbosch** – facilitator and investor of the location of the GRIDS, Mariënburg
- **Students** – top students are required for a successful setup of the Bachelor and Master
- **To be recruited researchers** – the basis of the research department at the GRIDS will be delivered by the researchers. It will be key to find researchers with an entrepreneurial and interdisciplinary profile to stimulate this type of environment at the GRIDS and to ensure the GRIDS creates and international name with this profile
- **Companies** – a unique aspect of the GRIDS it its close collaboration with the business, both in education (facilitating of courses), research (sponsoring PhDs or projects) and the compete ecosystem (funding the GRIDS). To enable a successful ecosystem a critical mass is required of companies partnering with the GRIDS. Two types of companies are distilled:
  - o **Companies for sponsorship** – these companies connect themselves to the GRIDS ecosystem by investing in it. These investments are required for the ecosystem to become viable. In return companies will get insight into research, the possibility to have interns etc. Type of companies for this category are: Philips, SAP, Oracle
  - o **Companies for collaboration** – next to companies heavily investing in the GRIDS, it is also necessary to attract some companies with a worldwide exponential brand name to the GRIDS, mainly for marketing purposes. This category includes companies like Adyen, LinkedIn, Spotify

Communication messages

As these stakeholders all have different objectives why they would join forces with the GRIDS and the benefits they can get from it, also the message that the GRIDS communicates to them should be tailored to their needs; it is key that their needs are addressed in the message that will be send to them. Table 7 highlights the key messages per stakeholder group.

Table 7. Key messages from GRIDS to stakeholders

Stakeholder	Key messages to stakeholder groups
TU/e and TiU – Executive Boards	- Collaborating with another university results in more knowledge sharing in a field of science that is linked with the current portfolio - International recognition, due to the international ambition of the school - Improved reputation of school for entrepreneurs, attracting new types of students - Complement current curriculum of Engineering (TU/e) or Social Sciences (TiU) with entrepreneurship in Den Bosch
TU/e and TiU – Deans and professors	- Can benefit from international reputation of GRIDS - Can start new types of projects with an entrepreneurial twist together with the GRIDS
TU/e and TiU – Current researchers	- Can learn from experience of the GRIDS on collaboration with the business - Can benefit from international reputation of GRIDS

Province North-Brabant
 	
City of Den Bosch
	- Boosting the region / city on:
	  o Attracting highly educated students (later to become workforce) and researchers
	  o Attracting business to the region through the ecosystem
	  o Building an even greater reputation of smartest region
	  o New businesses through start-ups and spinoffs

Students	- Being educated in a field where there is a high demand for (multidisciplinary data scientists) - Getting in contact through GRIDS with high-profile regional / national businesses - Being educated *and* supported in starting up data science companies

To be recruited researchers	• Work in a field where there is a high demand for (multidisciplinary data scientists) • Getting in contact through GRIDS with high-profile regional / national businesses, which could lead to new opportunities on how to fund research • Using Data Science to address today's and tomorrow's most pressing business and societal challenges (or unmet business and societal needs) • Being supported in starting up data science companies
Companies	• Attract the best talent with the best skill fits for your Data Science vacancies • Cooperate in highly innovative research (potentially together with R&D department), exploring new territories of Data Science that help develop new business and new business models • Apply new-to-the-world, theme-based research to improve business outcomes and society at-large • Utilize resources associated with the Data Science school to improve business agility • Having access to excellent intrapreneurs

Communication planning

To ensure the GRIDS is successful it is critical to send out the right message at the right time to keep momentum and ensure buy-in of stakeholders. When engaging stakeholders there are four commitment stages that need to be taken into account:

1. **Awareness** – general knowledge on the GRIDS:
   o What is the GRIDS?
   o Why it this starting up? Why now?
   o Where will it be located?
2. **Understanding** - High-level understanding of the educational, research and ecosystem plans
   o What do the programs look like?
   o How can the stakeholder get involved?
3. **Support** – Individual stakeholder are receptive to collaborating and / or sponsoring the GRIDS
   o What are the expectations from the stakeholder?
   o How will this benefit the stakeholder?
4. **Commitment** – Individual stakeholders agreed to funding or working together with the GRIDS and are actively involved in contributing to specific educational and research programs
   o What needs to be put in place to start the collaboration?
   o When does what needs to be arranged?

The timing per stage differs per stakeholder group, as not all groups need to be on board at the same time. Bachelor students for example will need to commit before May 1st 2016, but before they will actually subscribe to their new study they will want to know which companies are involved. Also internally involved stakeholders will have to approve the plans first before they can be communicated to externals. Therefore it needs to be detailed out which stakeholder group is informed when. The goal of the plan is to drive stakeholder groups from awareness to support and commitment to the GRIDS.

Throughout development stakeholders fall within different stages of the commitment stages. Figure 2 gives an overview of which stakeholders to involve at what level at which point in time.

Figure 2. Commitment stages per stakeholder group

Communication channels

Finally it needs to be determined through which channels the stakeholders will be reached. This depends on the stakeholder and the commitment stage they are in. Table 8 shows the overview of communication channels.

Table 8. Overview of communication channels per commitment stage

Stakeholder group	Commitment stage	Communication channel
TU/e, TiU – Executive Boards	Commit	• Meetings with core GRIDS team • Interviews with key stakeholders
TU/e, TiU – Deans and Professors	Aware	• Information meeting
	Understand	• Interviews with key stakeholders • Keep informed via mailings
	Support	• Interviews with key stakeholders • Keep informed via mailings
TU/e, TiU – Current researchers	Aware	• Information meeting
	Understand	• Q&A via contact person • Keep informed via mailings
	Support	• Q&A via contact person • Keep informed via mailings
Province North-Brabant	Commit	• Meetings with core GRIDS team • Interviews with key stakeholders
City of Den Bosch	Commit	• Meetings with core GRIDS team • Interviews with key stakeholders
Students	Aware	• Website TU/e, TiU • Website GRIDS • Social media (LinkedIn, Facebook, Twitter) • Study guides • Flyers at high-schools
	Understand	• Events (e.g. *Studiekeuzebeurs* at the Jaarbeurs) • Website TU/e, TiU • Website GRIDS • Open day at university • Information packages
	Support	• Website TU/e, TiU • Website GRIDS • Open day at university • Information packages
	Commit	• Subscription via *studielink* • Onboarding information package

|		
To be recruited researchers	Aware	• Network of GRIDS team • Website TU/e, TiU • Website GRIDS • Social media (LinkedIn, Facebook, Twitter) • Flyers or folders at universities / conferences
	Understand	• Network of GRIDS team • Website TU/e, TiU • Website GRIDS
	Support	• Meetings with university staff and recruitment • Information packages
	Commit	• Meetings with university staff and recruitment • Onboarding information package
Companies	Aware	• Network of GRIDS team • Information meeting
	Understand	• Network of GRIDS team • Information meeting • One-on-one interviews / meetings • Website GRIDS
	Support	• Meetings • Newsletter (to inform about progress)
	Commit	• Meetings • Newsletter (to inform about progress) • Onboarding information package

Branding visuals

In response to Request for Proposal (RFP), Deloitte developed concept branding for the imitative complete with colors, messages and look and feel. This branding is a concept and should be expounded upon in subsequent phases as the GRIDS initiative moves closer to kick-off. These concepts are meant to be a starting point for inspiration and to image what is possible.

The color palette, with blue and purple at each end, is meant reflect the characteristics (the rational and emotional) present in a GRIDS data scientist. The first set of logos set against a white and purple background are meant to provide contrast for use in different forms of collateral or on a website. Supporter logos have also been included for potential ecosystem partners. The idea being that GRIDS partners could display their commitment publically using a logo similar to these examples.

Finally individual logos have been included for each part of the GRIDS:

- **GRIDS logo:** the overarching brand in the hierarchy, the wording in show connecting to the gray T's of the GRID (connected to the 'T-Shaped' student educated within GRIDS).
- **Graduate School Data Science Mariënburg logo:** The M is this logo has been developed with dots representative of different data points.

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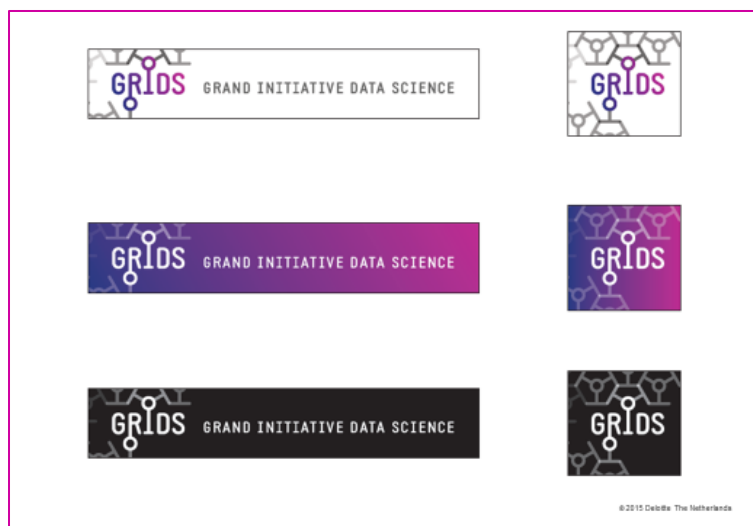
MARIËNBURG
GRADUATE SCHOOL
DATA ENTREPRENEURSHIP

MARIËNBURG
GRADUATE SCHOOL
DATA ENTREPRENEURSHIP

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Abbreviations

The table below contains common abbreviations (abv. below) used throughout this work product.

Abv.	Meaning
B	Billions
BI	Business Intelligence
BOM	Brabantse Ontwikkelings Maatschappij
BSc	Bachelor's
CRM	Customer Relationship Management
DCF	Discounted Cash Flow
DNA	Deoxyribonucleic Acid
DSC/e	Data Science Center Eindhoven
DSCt	Data Science Center Tilburg
ERP	Enterprise Resource Planning
EU	European Union
GDP	Gross Domestic Product
GRIDS	Grand Initiative Data Science
HORA	Hoger Onderwijs Referentie Architectuur
HR	Human Resources
HR&F	Human Resources & Finance
ICT	Information and Communications Technology
IoT	Internet of Things
IP	Intellectual Property
IT	Information Technology
LMS	Learning Management System
M	Millions
m^2	square meters
MOOC	Massive Open Online Course
MSc	Master of Science
NL	the Netherlands
OECD	Organization for Economic Co-operation and Development
PCO	Program Coordination Office
PDEng	Professional Doctorate in Engineering
PE	Private Equity
PhD	Doctor of Philosophy (Doctorate)
PR	Public Relations
Q&A	Question & Answer
R&D	Research & Development
RFP	Request for Proposal
RIS3	Research and Innovation Strategy for Smart Specialization
SMEs	Small and Medium Enterprises
SWOT	Strengths, Weaknesses, Opportunities & Threats
TBD	To be determined
TiU	Tilburg University
TU/e	Eindhoven University of Technology
U.K.	United Kingdom
U.S.	United States of America
VC	Venture Capital
VWO	Voorbereidend Wetenschappelijk Onderwijs
YTD	Year-to-date

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