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LAA Whitepaper Series

DATA SCIENCE TO ACCELERATE INNOVATION

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01 Abstract

The advancements of data science have enabled significant transformations of both operational and customer-facing processes in the last twenty years. Organizations are now empowered to use internal and external data to fuel and accelerate innovation processes and deliver state-of-the-art solutions to the customers in an agile, transparent, and customer-centric way. The objectives of this paper are to:

1. Provide the findings from a research on how data science is linked to innovation
2. identify with an online survey if organizations worldwide have implemented data science to accelerate innovation
3. identify and report the benefits and drawbacks of data science implementation
4. propose further actions and research required to develop an organizational assessment for data science transformation.

Keywords

Data Science · Innovation · Customer-centric · Transformation · Maturity · Survey · Accelerating innovation · Big Data

Content

02 Introduction

The data science term was coined by J.C. Wu in 1997 [1] as a modern expression describing advanced statistics. Cleveland in 2001 proposed a plan for a new discipline that would expand the technical areas in the field of statistics which he called data science [2]. Data science has since expanded from a discipline only addressing the needs of statistical society into a widely taught and researched field applied in organizations worldwide. In 2015 Donoho [3] highlighted high investments into research and education in the United States of America. There the major universities like UC Berkley, NYU, MIT, and the University of Michigan strongly support data science initiatives steering away from the traditional statistics towards the adoption of other tools and methods applying machine learning, artificial intelligence, etc. “Data science is a discipline that provides principles, methodologies, and guidelines for the analysis of data for tools, values, or insights” [4].

Data science is growing in popularity and academic attention [5] as well as the adoption in organizations worldwide. Nevertheless, the big data scientist of today must not only understand the algorithms and programming but should incorporate also also business perspective. Dumbill [6] states data scientists besides understanding the domain and connecting the dots, they also require business knowledge to understand the challenge to be solved.

We are standing today in the VUCA world [7] short for volatility, uncertainty, complexity, and ambiguity where businesses must find a way to navigate to cope with these 21st-century challenges. Many are relying on the raw material of the century – data [8]. A single organization can generate data from a variety of sources like social media, audio and video, website log files, data from geolocation [8], production and business processes, CRM systems, etc. Data must be collected, stored, analyzed, and understood to act upon findings that derive value for business decisions may it be feeding into internal improvement initiatives to increase efficiency or driving innovation to provide new products and services tailored to the customer. In spite of the increased interest in digital transformation and the industry 4.0 in the last few years, still, the majority of companies are at the very beginning of their journeys to leverage data for the future of innovation [9]. In 2017, the authors have designed a survey which was completed by 76 practitioners about the industry 4.0 implementation strategy to identify their challenges and gaps. The results showed that data science is strongly linked with digital transformation initiatives and the lack of higher-level vision and strategy can influence the data science domain as presented later in the paper.

03 Methodology

Through this paper, the authors aim to answer the following research questions:

- **Are organizations currently using data science to accelerate innovation?**
- **What do practitioners understand as data science?**
- **What is the current level of data science adoption in organizations worldwide?**
- **Which are the benefits, drawbacks, and best practices in organizations as a result of their data science implementation journey?**

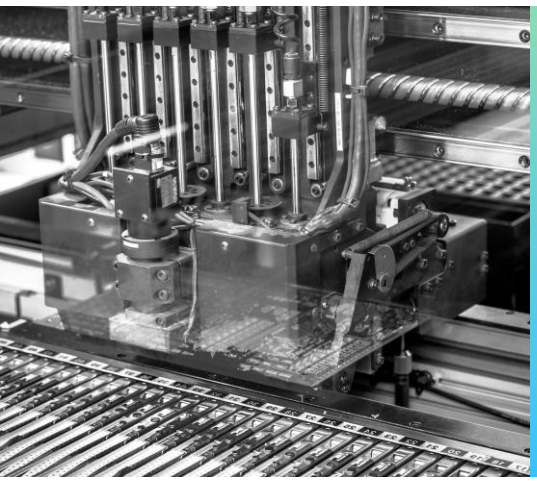
The iLEAD3 approach [10] consisting of six research steps was followed during the research as shown in Fig 1. In the first (Identify) phase the need for the research was recognized, research partners identified, and the research questions specified. In the second phase (Learn), the state-of-the-art literature review was conducted aiming to identify the definition of data science and state of the art in data science as well as identifying the published use cases in organizations.

In the third (Explore) phase the authors conducted an online survey targeting practitioners in the innovation and data science fields across industries to identify practices, challenges, and benefits of the implementation.

The online survey was selected as the most suitable method to reach a high number of worldwide data science professionals in a short time (64 days). 21 survey questions originated from the literature review and were reviewed by data science and innovation experts before conducting the survey.

In the fourth phase (Analyze), the survey answers were analyzed to extract insights and summarize answers provided by the practitioners. In the fifth (Develop) phase the authors combined findings from previous phases to provide new learnings in academia and industry. In the last (Deliver & Diffuse) phase the authors present the findings at innovation and data science events.

iLEAD³ Research Framework



Data is processed and analyzed to fuel process, marketing, or business innovation.

04 Data Science to Accelerate Innovation

In 1934 Schumpeter [11] defined innovation as “the new combination of new or existing knowledge, resources, equipment, and other factors”. The value-added for the organization, customers, and society by providing new customer-centric solutions derives from an effective innovation process set by the innovation strategy. Any organization can innovate in at least 12 different ways in four different anchors (offerings, customers, process, and presence) [12] and to do so efficiently many organizations could become an ambidextrous organization, focusing on incremental improvements in their day to day operations and also investing on futuristic more disruptive innovations [13]. In other words, an ambidextrous organization maintains a balance between continuous improvement activities supported by incremental innovation and adapting to the V.U.C.A. environment and developing future proof innovations that could be supported by data science [14].

Data science can help organizations to speed the innovation by providing multiple inputs on different development stages or support the change of direction identified through analysis of the existing data collected through various internal and external channels. Data is processed and analyzed to fuel process, marketing, or business innovation [15].

Organizations could exploit data more efficiently to accelerate the innovation activities. The current focus on incremental improvements such as automating reports or improving data visualization should shift more towards targeting the creation of new products, services, or business models, for instance, providing new services capitalizing the data already available and offering it to the market. Real-time data obtained from sensors and other IoT technologies including requests from customers, market, and organizational behavior is now reported and available to decision-makers within minutes instead of months [16], thus significantly improving the speed of the decision-making process. The power in the use of the transformative capacity of data science lies in the agile deployment and exploitation for innovation [16]. The Fast Company assesses yearly the world's most innovative companies [17].

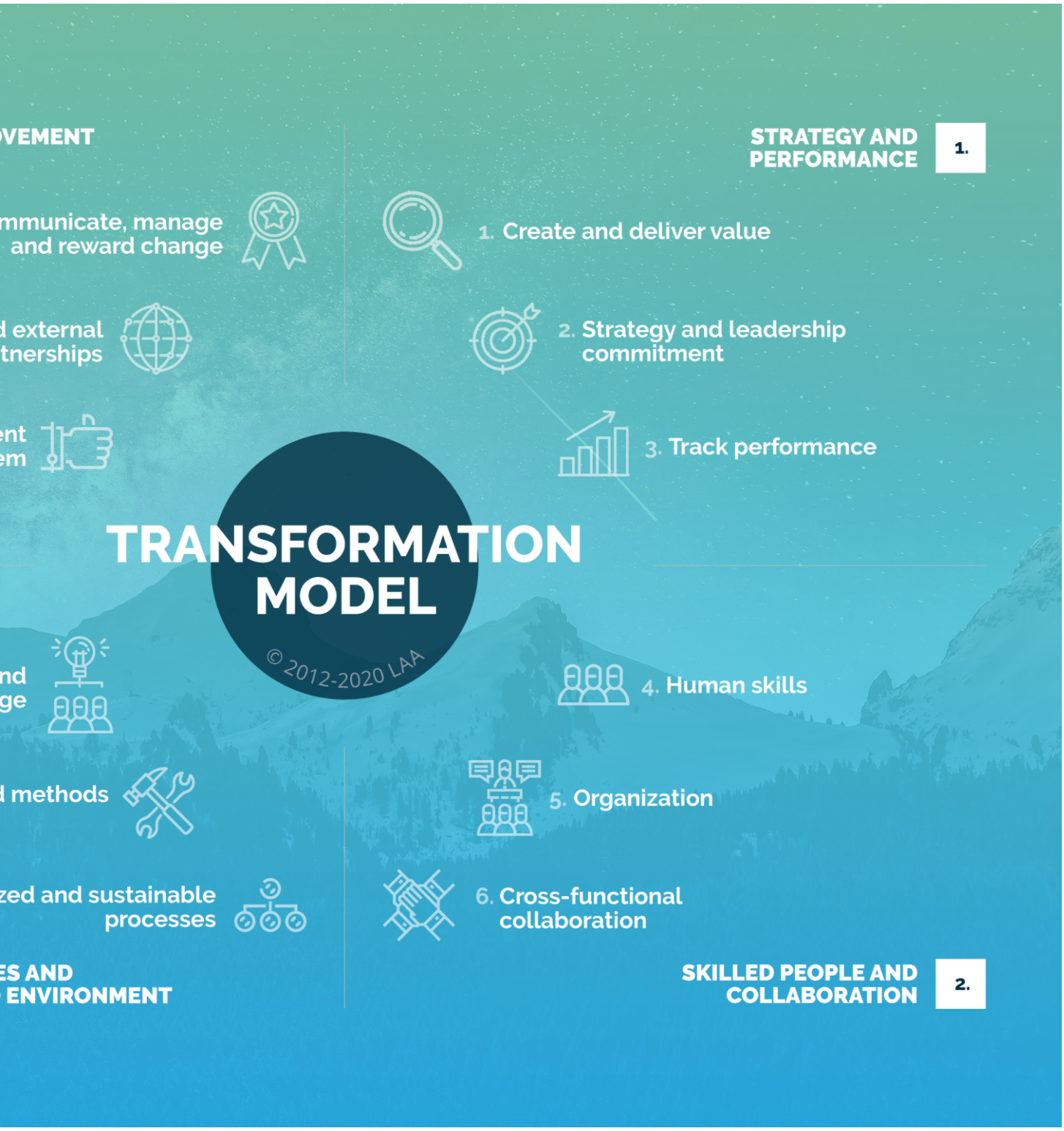
All the top honors from 2017 until 2019 were awarded for the success in the use of data science and surprisingly many of the organizations listed are non-data organizations. Where digitally native organizations easily understand the value of data, it is more challenging for the legacy-based traditional organizations that are starting the transformation journey. There are several examples available in the public knowledge of organizations that have successfully transformed with the use of data, for example, the Netflix case [18] as a reference in the entertainment business. Netflix started as a rent-by-mail DVD service company in 2007 and transitioned from a subscription model into online streaming [19] later and data analytics has played a key role during its transition. Data science is helping Netflix to strive in the new "all included" pay-for-subscription business model now supporting more than 151 million users with personalized recommendations based on the subscriber preference fetched as a continuous stream of insights from the customers [19]. On the other hand, Caterpillar, a manufacturing company has transformed its business model from offering heavy-duty machinery to full site management services supported by industry 4.0 technologies [20]. It did so by identifying the need from data obtained from sensors on physical products commissioned to the customers. Data collected and analyzed showed that there is a market for a service-based offering that Caterpillar has capitalized from offering more value to their customers from a product/service offer based on data.

Data science must have an explorative approach – an open-ended quest to seek insights into patterns and trends to further define the roadmap to successfully connect data models with business benefits. Data science projects in their early phase are characterized by a complex interplay between different stakeholder interests, competencies, and perspectives. For business transformation, this step is critical and should be holistic by involving innovation leaders and even external ecosystems of partners collaboratively taking advantage of business information and data analytics. For example, a hotel chain can collaborate with airline operators and a weather company to predict accommodation demand and room availability to maximize revenue adding value by removing inconvenience for the airline passenger.

Lean

Fig 1. *Transformation model*

Analytics Association's Transformation Model



The implementation of data science in an organization is not only an implementation of tools and methods but requires a holistic transformation of the organizational culture towards a data-based decision making and transparency. The authors used the LAA's Transformation Model [21] as seen in Fig 1 to structure the survey and the results. The model incorporates four main building blocks to structure every transformation 1. Strategy and Performance, 2. Skilled People and Collaboration, 3. Efficient Process and Knowledge-based Environment, 4. Continuous Improvement and Change; subdivided into 12 enablers. The transformation model integrates both technical aspects as well as soft practices like collaboration and leadership to support a successful data science transformation.

05 Research results

As part of the explore phase in iLEAD3 research methodology, an online survey was designed and rolled out between 28th August and 31st October 2019 to industry professionals worldwide.

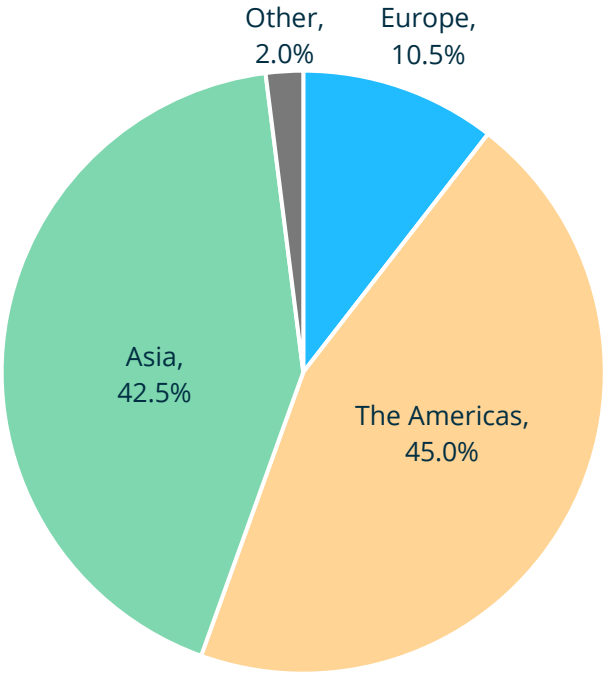


Fig 2. *Survey participants' demographics*

The survey has reached 200 participants answering most of the 21 questions.

Most of the participants are from The Americas (45%) and Asia (42.5%) with 10.5% of participants from Europe and other (2%) continents.

Most of the sample is affiliated with the research and education industry (20%), the manufacturing sector (16%), and IT (12%) as shown in Fig 3.

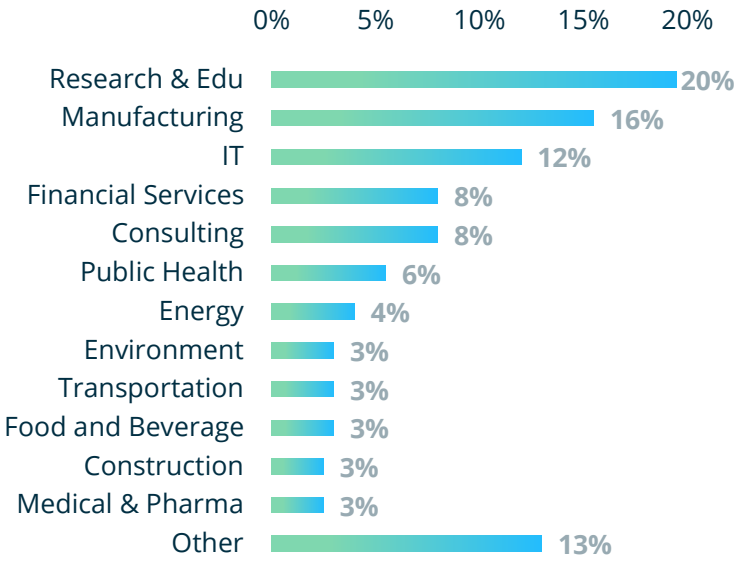


Fig 3. *Survey participants' industry affiliation*

05.1 Data Science: Strategy and Performance

The respondents have self-assessed their current status of data science implementation in their organizations by selecting one of the five data science maturity stages.

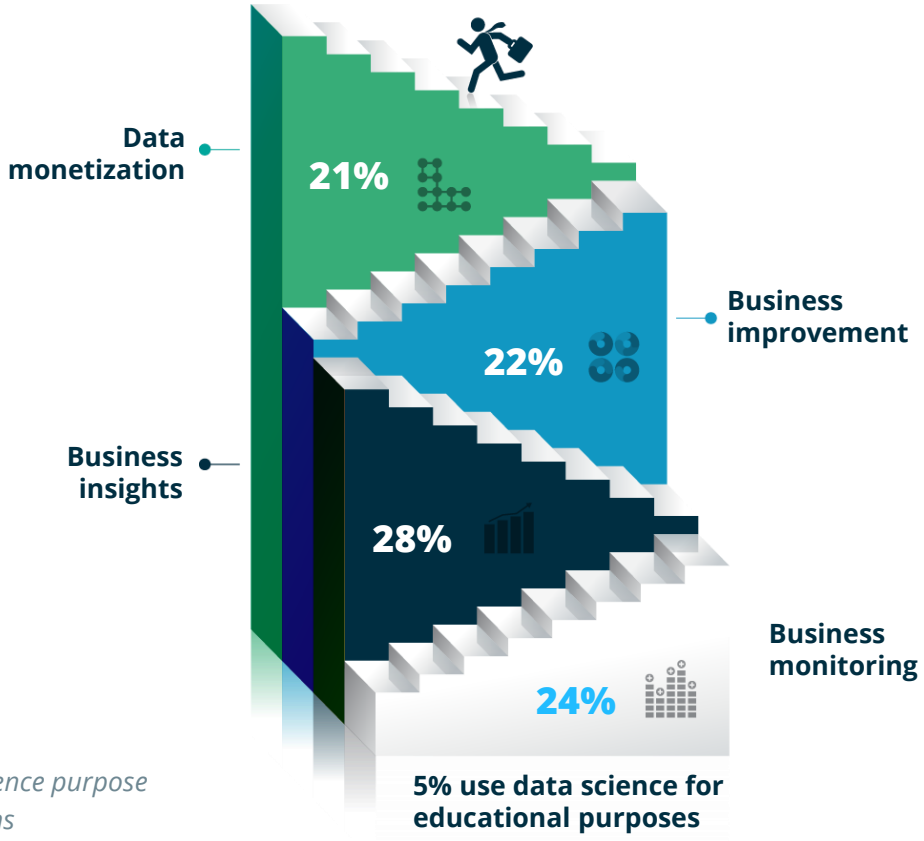


Fig 4. Data science purpose in organizations

The business monitoring stage (24%) is where organizations collect relevant data from their processes/departments and have identified metrics to be monitored and tracked regularly. It helps to understand the current performance trends and enables timely intervention and root cause analysis of challenges. Business insights (28%) is a stage where an organization is not only collecting and reporting metrics for reviews but in addition performs comparative data analysis to get more insights for challenges and opportunities like powerful visual analytics or statistical analysis. The business improvement stage was selected by 22% of survey participants as seen in Fig 4 where the organizations perform extensive inferential statistical analysis and machine learning models to predict business outcomes in a tangible manner thus expediting the process of improvement. These organizations involve statistical experts and process/department leaders for such initiatives/projects.

Data monetization reported by 21% of survey respondents is a stage where the maturity of analytics implementation enables the company to identify new market opportunities and develop new services/products or business models based on the insights from data. Only 5% of the survey respondents use data science for educational purposes. When asked to report the yearly investment into data science the survey respondents noted a broad spectrum of values ranging from 10,000 USD up to 300,000,000 USD. The participants reported data science is mostly used in the following five verticals in organizations: business analytics (52%) followed by research and development (47%), customer service (34%), finance (33%), and marketing (30%).

05.2 Data Science: Skilled People and Collaboration

The responsibility to drive data science projects in an organization is mainly led by the head of the analytics (22%) and the CEO (16%). The Chief Information Officer (CIO), professors at the research institutions, and other individuals lead in 10% of the cases. The minority of the individuals leading data science projects are CTO (Chief Technology Officers) and DTO (Digital Transformation Officers) in 8%, CDO (Chief Data Officers) and OpEx (Operational Excellence) leader in 4% and 2% each CMO (Chief Marketing Officer) and knowledge management leader.

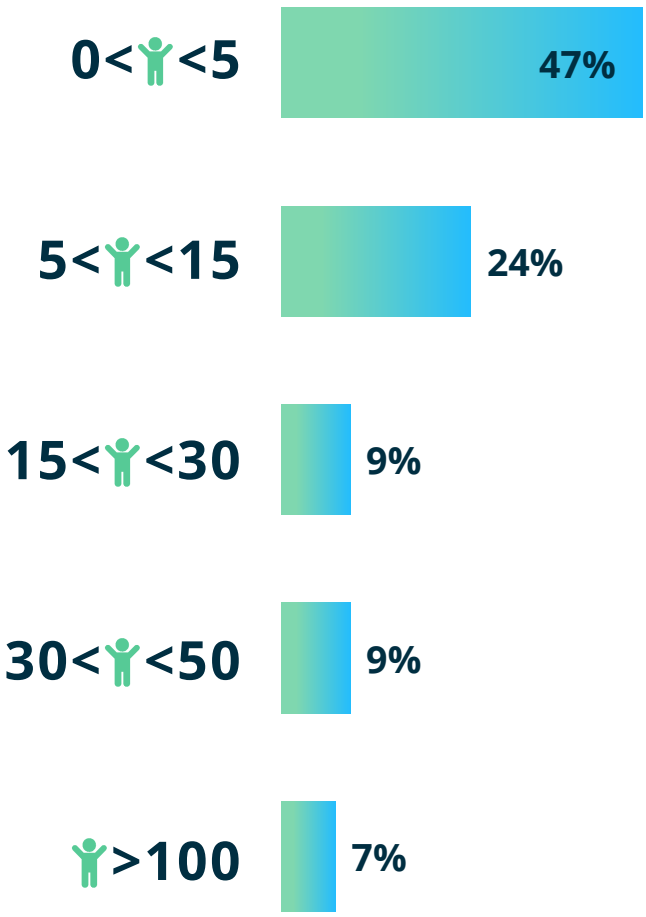


Fig 5. *Data Science team size*

Data science teams in most organizations (47%) do not exceed five employees (Fig 5). The survey shows 24% of organizations have data science teams with more than five and less than fifteen members.

The share of organizations with larger teams is smaller, and only 7% counts with a team of more than 100. Additionally, 97% of respondents believe the requirement for a skilled workforce in data science initiatives in their organization will increase in the next five years.

The most often reported hard skills are statistics and programming in Python followed by skills on data, visualization, and programming.

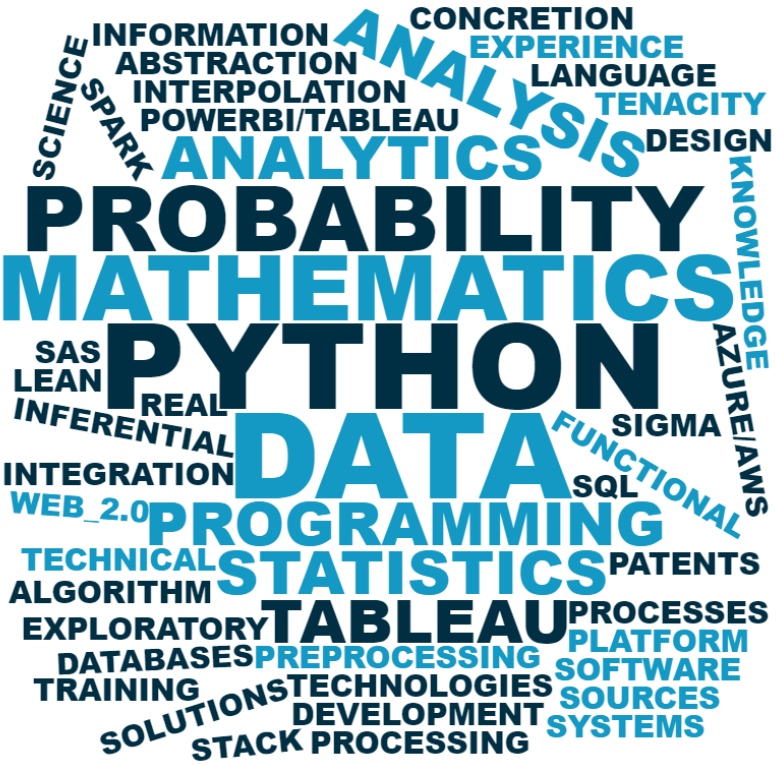
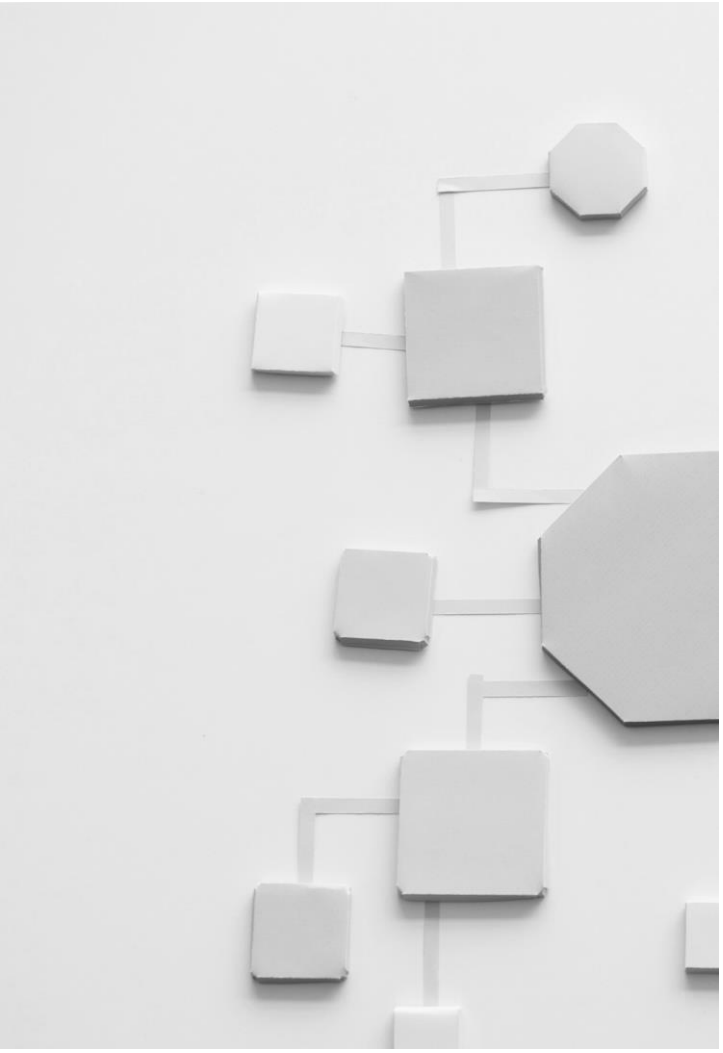


Fig 5. *Word clouds of* ***soft skills*** *(top) and* ***hard skills*** *(bottom) required for data science initiatives reported by survey participants.*

05.3 Data Science: Efficient Process and Knowledge-based Environment

Most of the survey respondents use at least one data analytics software with Python leading as the most often used programming language and Tableau as the most often used software for data visualization. A variety of other languages and software packages were reported in a smaller share.



05.4 Data Science: Continuous Improvement and Change

The reaction of the employees to data science implementation was reported as positive but passive by half of the sample, with one-quarter of respondents reporting welcoming and proactive behaviors and a quarter noticed resistant behaviors of the employees towards data science. To provide current up-to-date knowledge and continuously upskill employees and provide state-of-the-art knowledge about tools and techniques, 76% of respondents utilize methods of on-the-job learning, 40% leverage refresher courses offered either by tool providers or other parties, 31% leverage in-house knowledge and utilize peer-to-peer learning through mentor-mentee programs, 24% participate in networking events and 12% frequently enroll employees to university courses to bring back the latest trends and practices concerning data science.

05.5 Challenges of Data Science Implementation

Survey participants selected three main challenges of data science initiative implementation based on the level of occurrence in the organization. Access to data has been identified by 61% of respondents as the most often occurring challenge. Understanding of data (52% respondents) and lack of knowledgeable workforce and experts (44%) were identified as the other top issues preventing successful implementations.

05.6 Benefits of Data Science Implementation

When prompted to report the benefits observed during and after data science implementation, the survey respondents listed five main benefits:

1. Optimized decision making
2. Increased productivity
3. Cost savings
4. Keeping ahead of the competition
5. New business model development

06 Conclusions and next steps

The advancements of data science as a horizontal discipline supporting different functions is still a new practice that has not yet been explored enough in organizations worldwide. Organizations rarely use data science outputs to inspire and speed up the innovation process. The majority of organizations worldwide still do not explore the full potential that data science can bring to accelerate innovation contributing to sustained business improvement and data monetization activities. Most organizations from the research sample use data science for the following three activities:

1. To monitor the business (24%)
2. To report on the current activities providing business insights (28%)
3. To improve the business (22%)

The highest maturity level of data science use is reached when an organization applies the insights gained to monetize data and develop new products and services to offer to an existing or new target market.

Currently, an integration and roadmap creation for data science initiatives is not yet a common practice supported by industry 4.0 activities and as observed in the worldwide survey the investments vary from minimal to large sums invested. The dispersed responsibility for data science initiatives that include many of the leading roles shows a lack of strategic direction and integration into the existing organizational structure. Data science initiatives need to become better integrated into the existing value chain and linked to the innovation department to leverage the findings.

The relative newness of the data science field results in difficulties accessing data, understanding data, and the availability of a knowledgeable workforce. Interestingly, there is a perception in the industry that

to have successful data science projects the key challenge is to develop hard skills. Hard skills imply core knowledge of statistical and AI methods and tools along with the use of technology. It has been identified that it is equally important to develop a strong soft skill set to be successful in data science implementation and specially to exploit the findings to fuel innovation.

Soft skills such as business communication, change management, stakeholder management, and project management are critical. Data scientists must be able to address business challenges and communicate results obtained from data analysis through data visualization methodologies equipping decision-makers with necessary facts to drive the business and innovation activities. A data-driven culture needs to be adopted in the organization so that the outcomes of data science initiatives and implementations like a new campaign or a new product can be designed and communicated to the respective teams and functions who would be taking those ahead. Support and co-operation of all the other functions are necessary to reap the benefits of successful implementations in a sustained manner. Hence change management is crucial.

Data science benefits obtained by the survey respondents are optimized decision making, increased productivity, and cost-saving, yet there is still an opportunity to better integrate industry 4.0 technologies to drive innovation and understand better the competitive advantage data science can bring to the industries worldwide.

06.1 Next Steps

As the next steps, the authors propose to develop detailed cases of successful organizations worldwide that have applied data science and have reported benefits influencing innovation capabilities. A maturity assessment to assess the implementation of data science is proposed based on the ISO 24668 standard "Process management framework for big data analytics" under construction.

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About the Lean Analytics Association

The Lean Analytics Association (LAA) helps organizations around the world throughout their transformation journeys, inspiring and enabling them to learn about the latest trends, lean methodologies, best practices and digital technologies to speed the launch of innovative human-centric solutions and to improve their operational efficiencies. We strive to develop leaders and engage employees towards a continuous problem-solving culture.

The LAA was founded in Switzerland in 2012 as a spin-off of École Polytechnique Fédérale de Lausanne (EPFL) with a purpose to disseminate and exploit the outcomes of the European Lean Product and Process Development (LeanPPD) project. Ever since, the LAA has been actively working and researching the latest advancements in lean thinking for innovation and new product development.

Today, the LAA has grown beyond the outcomes of the LeanPPD project as we develop new solutions, which benefit the lean community, our partners and innovation professionals around the world. We are establishing strong foundations for education in areas of lean product development, integrated innovation, service design, and business optimization.

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01 2009
LeanPPD
Kicked-off the Lean Product & Process Development EU project with €7.4m funding

02 2012
LAA
Launched the Lean Analytics Association (Spin-off of the EPFL in Switzerland)

03 2013
Lean Transformation Model
Developed the DARE Cycle and the Lean Transformation Model

04 2014
Growth of the LAA Team
Welcomed 3 new team members, enabling accelerated organizational growth

05 2015
Best Practices Project
Launched the worldwide Best Practices Discovery Project

06 2016
First Annual Forum
Organized the first annual Lean Innovation Forum in Lausanne, Switzerland

07 2017
First book
Published our first book: The Lean Product Development Best Practices

08 2018
Global outreach
Developed the DARE2LEAN kit and took our conference global

09 2019
Expanding internationally
We focused on building new collaborations, partnering with new clients to help them drive innovation and increase their business performance

10 2020
Second Book
Published the second book: Dare to Gemba Walk: A practical approach for leader and teams towards collaborative problem solving

About the Data Science Foundation

Data Science Foundation is a platform for data science and AI. It is a melting pot of intellectual exchange and standardization vis-a-vis the exciting storm of ever-increasing adoption and application of cutting-edge technology boosted algorithms of data science and AI by corporates, government sectors and social good.

Data Science Foundation is a platform that offers liberty to a data scientist to contribute to the growing field of data science/AI beyond the four-wall boundaries of an organisation for the benefit of the community of data scientists, aspirants and other stakeholders.

The Data Science Foundation is based around five principles:

1. Identify and share best practices and models in analytics lifecycle
2. Expand knowledge and skill by sharing knowledge, resources, certifications in Data Science
3. Develop standards and frameworks for easier adoption by different stakeholders and user groups
4. Analytics services sector is multi-facet and there is immense opportunity to identify right nodes of collaboration
5. Establish a platform to share impact and opportunity of Analytics service

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Business Brio was established in 2013 with a focus on Business and Social Development Analytics. Led by a team of accomplished corporate veterans, Business Brio possesses significant experience in corporate and development sectors and imparts valuable technical skills to any assignment – irrespective of its size or scope. The experience of the management team encompasses coveted Fortune 500 companies like GE, Accenture, Infosys, Nielsen, Fidelity among others across the globe.

Business Brio has worked with large corporate clients to deliver analytics solutions in Financial Services and Insurance, Manufacturing, Telecom, Consumer goods, and Social sector in the USA, India, Middle East and UK.

Business Brio is contributing to the development of world's first standard on AI - process framework for Big Data Analytics under the umbrella of ISO, holds multiple IPs and patents in analytics based systems and is ISO 27001:2013 certified. Business Brio is also the recipient of NASSCOM Analytics Excellence award and featured in Top 10 Analytics solution providers by CIOInsider.

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