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Research Paper

Big Data Education Landscape for Graduates in Morocco: Insights from 2022 Offerings

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Abstract

The main objective of this research was to analyze graduate programs in Big Data in Morocco in 2022, focusing on the technical skills, tools and technologies, and functional skills taught in the programs. In the digital age, the Big Data revolution has generated massive amounts of data, transforming the way businesses and organizations around the world make decisions and innovate. In this ever-changing context, Training of Big Data professionals in Morocco in 2022 is crucial. The expansion of Big Data has created a growing need for skilled professionals to manage these immense data sets. Higher education programs play a key role in preparing these future experts. This study adopted a content analysis methodology, examining the curricula of 16 public engineering schools, and 21 accredited public schools and science faculties in Morocco. The technical skills, tools and technologies, and functional skills taught were analyzed and compared with existing literature on Big Data skills. The programs focus on technical skills such as programming, machine learning, statistics, and mathematics, with Python as the main tool. However, certain skills, such as predictive analysis, are under-represented. Functional skills in communication and management are essential; however, skills in agile methods and change management vary in coverage. The results offer an insight into the alignment between higher education programs and the needs of the Big Data market. Educational institutions can adjust their programs to better meet emerging needs, focusing on under-represented skills, and ensuring the continued relevance of training.

Keywords: *Big data education; technical skills ; tools and technologies ; functional skills ; Morocco*

INTRODUCTION

In the current digital age, the world is experiencing an unprecedented revolution in the generation and collection of data. This rapid evolution has given rise to what is known as Big Data, a concept that encapsulates the prodigious amount of data generated every day (Jin et al., 2016). At the heart of this revolution is the ability to transform this raw data into actionable insights, propelling Big Data analytics to the forefront of innovation, decision-making and competitiveness for businesses and organizations around the world (Wamba et al, 2016).The introduction and spread of new digital technologies, such as social networks, mobile devices, Big Data, the Internet of Things, and Cloud Computing, have prompted businesses across a range of sectors to undertake numerous initiatives to explore and exploit the benefits of these technologies (Fitzgerald et al., 2013; Ross et al., 2016). Often, this involves external customer-facing transformations and internally focused transformations of products, processes, and even business models (Matt et al., 2015). As a result, businesses face rapid and profound change due to the increasing maturity of digital technologies and their ubiquity across all markets (Ebert et al., 2016).

Big Data refers to data sets that are not only voluminous but also diverse and generated at high speed, making them difficult to manage with traditional database management systems. This fundamental change disrupts traditional management practices, forcing modern businesses to adopt new perspectives to access 'strategic information' (Martinet, B. & Marti, Y.M., 2001). Although

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many studies have focused on Big Data analysis techniques, studying the skills required to manage these massive data is still preliminary.

In this ever-changing context, Training of Big Data professionals plays a critical role. Companies are looking for individuals with the skills and knowledge to manage, interpret and exploit these huge data sets (Davenport, 2014). Market needs are rapidly evolving and require specific technical and functional skills to effectively navigate the complex Big Data landscape. Acquiring such skills requires a suitable educational environment that is in tune with the challenges and opportunities of Big Data (Miller, 2014).

This study examines at the landscape of Big Data graduate programs in Morocco, focusing on the year 2022. We aim to explore the technical skills, tools and technologies, and functional skills taught in training programs while putting these findings into perspective with the existing literature. By examining how public engineering schools, private schools, and science faculties structure their Big Data training programs, we aim to identify trends and gaps, while assessing the extent to which training offerings reflect market needs. In this study, when we refer to 'graduates,' we specifically addressing individuals who have recently completed their tertiary education in Morocco.

While the importance of technical and technological skills is recognized, our study also aims to shed light on the preparation of future Big Data professionals from the point of view of functional and personal skills, such as change management, communication, and creativity. However, this study has limitations, particularly regarding the exhaustive coverage of personal skills.

By analyzing the results of Big Data graduate programs in Morocco and comparing them with existing research, we aim to contribute to a better understanding of how educational programs are train the next generation of Big Data professionals while identifying areas for improvement to meet the evolving needs of this rapidly changing field.

However, this study has limitations, particularly regarding its exhaustive coverage of personal skills. In this analysis of Big Data graduate programs in Morocco, we aim to contribute to a better understanding of how these programs train the next generation of Big Data professionals. At the same time, we identify areas for improvement to meet the evolving needs of this changing sector.

LITERATURE REVIEW

Big Data and Data Science

Big Data encompasses data sets whose size exceeds the capacity of traditional database management systems to capture, store, manage, and analyze them. The nature of Big Data varies from one sector to another, and it is often characterized by three fundamental dimensions, also known as the 3Vs: volume, velocity, and variety (Benkarrache & Ghanouane, 2020; Manyika et al., 2011). Volume refers to the considerable mass of data generated, velocity to the need to process it in real-time, and variety to its great diversity and heterogeneity (Benkarrache & Ghanouane, 2020; Gandomi and Haider, 2015). In addition, other dimensions such as variability, veracity, and visualization have been added to the concept of Big Data (Matt et al., 2015). Digital transformation, meanwhile, involves a complete overhaul of production and sales processes to increase their efficiency, using technologies such as cloud computing, the Internet of Things (IoT), Big Data, and mobile technologies (Petkovics, 2018). However, it is essential to note that the success of digital transformation also depends on the support of employees, as new technological approaches can be counterproductive without their buy-in (Petkovics, 2018).

Data science is an increasingly widespread term, linked to advanced data analytics. Initially used by scientists, it has taken on a new dimension in the business context, particularly with the

advent of big data and significant advances in artificial intelligence. It involves transforming heterogeneous, unstructured data into usable information (Davenport & Prusak, 1998), (Dhar, 2013; Agarwal & Dhar, 2014). Unlike traditional data analytics, data science seeks to discover unexpected and robust patterns in large datasets, without the need for a prior query. The terms 'data science' and 'data mining' are often used interchangeably, although data science encompasses broader concepts than simple data mining, incorporating techniques from a variety of disciplines (Provost & Fawcett 2013). The distinction between data analysis and data science is not always clear, but the use of the term 'data science' has grown with the emergence of big data and technological advances, while data analysis is a broader concept that also encompasses smaller data (Davenport, 2013; Davenport & Dyché, 2013).

Human skills in the face of the challenges posed by Big Data processing are a crucial element for the success of companies in this field. Thus, most companies find themselves obliged to seek specific Big Data skills (Anderson & Elf, 2015; Ghasemaghaei et al., 2018; Awan et al., 2021). According to the perspectives of Davenport (2013) and Granville (2014), the interpretation of data and its transformation into knowledge have always been the subjects of debate among various experts such as scientists, statisticians, computer scientists, and other related disciplines. The emergence of the concept of 'data scientist' is associated with Big Data, referring to professionals who specialize in generating knowledge by analyzing these large datasets.

Initially, the role of 'data scientist' was commonplace within companies such as Google, eBay, LinkedIn, and Facebook, where Big Data analysis formed the very core of their analytics activities (Davenport, 2013). However, in many other companies, Big Data must be integrated with traditional data sources, requiring a combined approach in the analysis process. Thus, different data analysis skills are required, such as statisticians, software engineers, developers, business analysts, Big Data architects, and data engineers, etc. (Hammerbacher, 2009; Davenport & Dyché, 2013; Granville, 2014; Miller, 2014).

Data scientists are typically trained in computer science, mathematics, or economics, but their backgrounds can be diverse, as long as their area of specialization is focused on data and computing (Patil, 2011; Davenport & Patil, 2012; Ranjan & Foropon, 2021). Harris, Murphy, and Vaisman (2013) extend this list to include more specific areas such as statistics, machine learning, databases, operations research, business intelligence, and the social and physical sciences. In the literature, it is possible to distinguish three categories of skills associated with Big Data. For the purposes of our study, it is crucial importance to discern and explore in depth the three distinct categories of skills associated with Big Data: technical, functional and personal. This distinction is not merely a semantic classification; rather, it forms the basis of our understanding of the multiple demands placed on graduates entering the Big Data labor market. This separation offers valuable insights into the specific areas where graduates may require further training and development to excel in the complex landscape of Big Data analytics.

Technical skills

In terms of technical skills, coding ability is a fundamental and universal skill for data scientists, enabling them to design prototypes (Patil, 2011; Kipper et al., 2021). Similarly, the growing demand from businesses to establish automated and predictive decision-making systems to decrypt Big Data makes machine learning a key skill (Dhar, 2013). In addition to machine learning, Dhar (2013) lists other essential skills for a data scientist in their assignments, including the following:

- Ability in Bayesian statistics, requiring a working understanding of probability, distributions, hypothesis testing, and multivariate analysis.
- Knowledge of data structures, algorithms, and systems, encompassing the concepts of distributed computing, databases, parallel computing, and fault tolerance.

- Familiarity with scripting languages such as Python and Perl.
- Understanding the concepts of correlation and causation.
- Use of tools and techniques from fields such as computer science, linguistics, econometrics, sociology, and other related disciplines.

Miller (2014) highlights that data scientists need to have a strong background in mathematics and statistics, as well as skills in machine learning, predictive analytics, programming, and computer science. They must also have core skills in information systems, databases, data warehousing, and data mining. In an ever-changing competitive market, companies are racing to attract profiles specializing in machine learning that able to design innovative algorithms (Miller, 2014). A study conducted by Pinola (2015), based on job advertisements, revealed that the skills most frequently required are: statistical literacy, machine learning skills, programming, data mining, algorithmic skills, and predictive analytics skills.

Professional skills

Professional skills refer to the practical skills and specialist knowledge that enable graduates to make a significant contribution to problem-solving and decision-making in the field of Big Data within their professional environment (Davenport & Patil, 2012). A data professional must have the ability to formulate problems in a way that leads to effective solutions (Dhar, 2013). The terms 'computational thinking', used by Wing (2006) and Dhar (2013), describe the fundamental skills needed by data scientists to navigate this sea of information. These skills were explored by Barr and Stephenson (2011), who identified several core capabilities, including data collection, data analysis, data visualization and analysis, abstraction, model analysis and validation, automation, testing and verification, algorithms and procedures, problem decomposition, control structures, parallelization, and simulation.

Beyond analytical skills, data professionals must also have a solid understanding of business and management, as well as expertise in data mining algorithms, while being able to identify business problems from a data perspective (Dhar, 2013; Waller & Fawcett, 2013; Provost & Fawcett, 2013). According to Davenport and Patil (2012), data scientists need to guide decision-makers through a data-driven dialogue and be able to communicate in a way that is understandable to all stakeholders, both verbally and visually. They must be able to make analysis possible by linking data to other data elements and sources while cleaning up the resulting datasets (Patil, 2011; Davenport & Patil, 2012; Jaradat, 2017).

Nevertheless, Big Data-specific skills need to be complemented by traditional database management skills, including data architectures, metadata, data quality and fixing processes, data management dashboards, master data management, matching algorithms, and other data-related topics (Davenport & Dyche, 2013). Given that analytical models are often integrated into business processes, Davenport and Dyche (2013) highlight the importance of mastering change management to implement the necessary adaptations in roles, process design, and skills.

Personal skills

Among the personal skills that define a data scientist in any field, curiosity, and associative thinking are prominent. These qualities are essential for identifying the questions and hypotheses that data scientists are seeking to resolve. Creativity is also essential for tackling problems in innovative ways (Patil, 2011; Davenport & Patil, 2012).

Davenport and Patil (2012) emphasized education and curiosity as key factors for any data scientist to make discoveries in the world of Big Data. In addition, data analysts must have analytical skills, be autonomous, and collaborate in real-time with their managerial peers to meet management challenges. To overcome technical constraints, data scientists need to be creative, determined, and resilient under pressure when they are in high demand (Davenport & Patil, 2012).

However, the literature offers several concordant descriptions of the characteristics (see Table no: 1) that data scientists should show.

Table 1. Non-Exhaustive List of the Many 'Features' that a Data Scientist

Data scientist features	Source
Expert in Big Data tools	(Miller, 2014 ; Song & Zhu, 2015 ; Provost & Fawcett, 2013)
Coder	(Davenport & Patil, 2012)
Statistician / Quantitative analyst	(Davenport, 2014, Provost & Fawcett, 2013)
Researcher	(Davenport, 2014)
Data Hacker	(Davenport & Patil, 2012; Conway, 2010)
Auditor	(Mayer-Schönberger & Cukier, 2013)
Data EthicsOfficer	(Miller, 2014)
Data manager and strategist	(Miller, 2014, Song & Zhu, 2015, Wixom et al., 2014)
Visualization expert	(Provost & Fawcett, 2013, Davenport & Patil, 2012)
Communicator	(Wixom et al., 2014, Chen et al., 2012, Song & Zhu, 2015, Davenport & Patil, 2012)
Project manager	(Song & Zhu, 2015)
Business expert / consultant	(Chen et al., 2012, Davenport, 2014, McAfee & Brynjolfsson, 2012)

Source: (De Mauro et al., 2018).

In summary, this literature review has highlighted the fundamental value of human skills in the ever-expanding field of Big Data. Technical, professional, and personal skills combine to shape the profile of an effective Big Data professional. The varied requirements, from mastery of tools and algorithms to communication skills and creativity, reflect the complexity inherent in handling massive data. As the Big Data landscape continues to evolve, human skills will continue to drive innovation and success in this field.

In the Moroccan context, Ghanouane (2020) adopted a two-stage methodology to explore the landscape of Big Data skills in job postings in Morocco. First, the researcher used Web scraping to collect data from job offers posted on Moroccan websites in 2019. After eliminating duplicates and incomplete data, he obtained a dataset of 80 jobs. He then applied content analysis to examine these vacancies and identify the technical skills, tools, technologies, functional skills, and personal skills required by Moroccan companies. The main findings of this study indicate that Moroccan companies are demanding regarding Big Data skills, giving preference to candidates with an academic background at the engineering or master's level. In addition, professional experience is an important factor, with 2 to 5 years of experience often required. The information system consulting, and financial sectors are the most in-demand for Big Data skills, accounting for the majority of job offers.

RESEARCH METHOD

In this study, we have chosen to use a content analysis methodology to examine the Big Data training offer for BAC+5 graduates in Morocco in 2022. Content analysis methodology is a research approach that aims to examine and understand in depth the textual content of a set of documents or data. This methodology is based on the work of Berelson (1952) and Mucchielli (1984) and consists of categorizing, coding and interpreting textual content to identify themes, patterns and specific information.

Our research procedure consisted of several stages. First, we collected data by closely examining the training programs offered by various educational institutions in Morocco, including public engineering schools, public schools and science faculties. This approach enabled us to cover the entire spectrum of Big Data training offered in the country.

Data collection

Data collection was carried out by closely examining the graduate programs offered by various academic institutions in Morocco (see Table 2). We considered training courses offered by public engineering schools, private schools, and science faculties. This holistic approach enabled us to cover the entire spectrum of Big Data training offered in the country.

We chose to analyze training programs aimed at BAC+5 graduates because they confer a master's degree and are therefore relevant to our study of higher-level training provision. In addition, by adopting a content analysis methodology, we were able to examine program descriptions in detail, including courses, modules, pedagogical objectives and targeted competences, which enabled us to obtain rich and specific information.

Table 2. List of Universities Offering Big Data Courses

Establishment	Graduate title	City
List of Public Engineering Schools		
National School of Applied SciencesFez	Master's degree in information system architecture and applications	Fez
École Hassania Des Travaux Publics Casablanca	Specialised master's degree in data engineering	Casablanca
National School of Applied Sciences Tangier	Computer Engineering	Tangier
Mohammedia School of Engineering	Computer Engineering and Digitalisation	Rabat
National School of Applied Sciences Oujda	Data Sciences and Cloud Computing Engineering	Oujda
National School of Applied Sciences Khouribga	Computer Science and Data Engineering -	Khouribga
National School of Applied Sciences Marrakech	Computer Engineering	Marrakech
National School of Computer Science and Systems Analysis Rabat	Data Genius	Rabat
National Institute of Posts and Telecommunications	Data Science Engineer	Rabat
National School of Applied SciencesEl Jadida	Big Data Engineering	El Jadida
National Institute of Statistics and Applied Economics	Data Science (DS)	Rabat
School of Information Sciences	Knowledge and Data Engineering	Rabat
List of Private-Schools		
Suptechnology	Master of Big Data	Casablanca
Supinfo International University	Master Of Engineering: Big Data Advanced	Casablanca
Advanced Studies in Engineering and Management Sciences HESTIM	Artificial Intelligence and Big Data	Casablanca
ESTEM	Data Science and Computer Development	Casablanca
School of Management and Computer Science	Master of Intelligent Applications and Big Data	Casablanca
International University of Casablanca	Data Engineering Science and Big Data	Casablanca
Euromed University of Fez	Big Data Analytics Engineering	Fez
List of Science Faculties		
Faculty of ScienceBen Msick	Master of Data Science and Big Data	Casablanca
Faculty of Science Fez	Master of Big Data Analytics & Smart Systems	Fez
Faculty of Science Rabat	Master's degree in data engineering and software development	Rabat
Faculty of Science Agadir	Master's degree in data science	Agadir
Faculty of Science Kenitra	Master of Big Data and Cloud Computing	Kenitra
Faculty of ScienceAin Chock	Master of Big Data and Cloud Computing	Casablanca

Faculty of Science Marrakech	Master's degree in data science	Marrakech

Source: authors.

Selection criteria

The selection criteria were established on the basis of the relevance and specificity of the training programs. We considered into consideration programs aimed at graduates, i.e., those conferring a master's degree, to target the higher-level courses relevant to the study.

Analysis process

The content analysis was carried out systematically. We began by examining in detail the information provided in the descriptions of the training programs. This included details of the courses, modules, pedagogical objectives, and the competencies targeted by each program.
The extracted data were then categorized and thematized according to different axes such as the technical skills taught, the professional skills targeted, the tools and technologies included, and any other distinctive features of the programs.

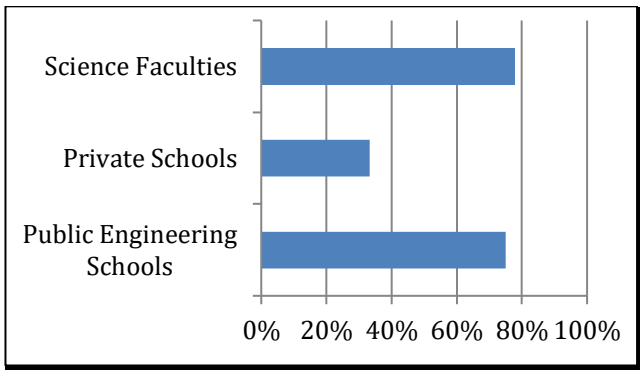
Finally, we adapted the content analysis methodology to our study by focusing on specific elements of the training programs, such as the technical skills taught, the professional skills targeted, the tools and technologies included, and other relevant features. This methodology enabled us to analyze in depth the Big Data training offer for graduates in Morocco in 2022, focusing on the key elements that were at the heart of our research.

FINDINGS AND DISCUSSION

Results

We identified 16 public computer science schools, 75% of which offer Big Data courses; the remainder still follow traditional 'computer engineering' courses (see Graph 1). As for private schools, of the 21 accredited schools we consulted, only 7 offer courses in Big Data analysis. This small number can be explained by the choice of private schools to offer cross-disciplinary courses in information technology: Big Data, Artificial Intelligence, Cloud Computing and Machine Learning are only modules at the end of the course (see Graph 1).

Lastly, science faculties, because of their capacity to offer courses in mathematics or advanced statistics, have all committed to offering master's degree courses in Big Data, accountingfor 78% of all science faculties in Morocco (see Graph 1).



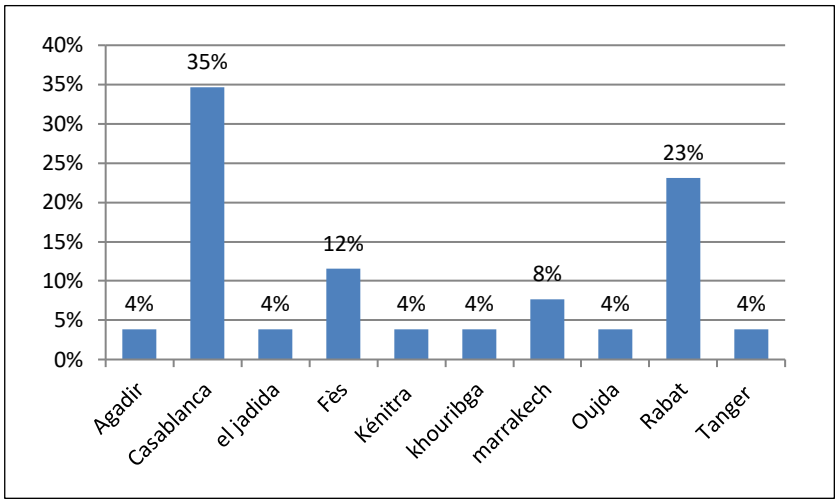
Graph 1. Number of Institutions Offering a Big Data Course/Number of Institutions Consulted

Overall, graduate programs are concentrated in Casablanca and Rabat, with 35% and 23% respectively of the total programs recorded. Similarly, the presence of at least one offer in the major Moroccan cities is explained by the presence of a science faculty in these cities. It should also be

noted that the majority of private courses are located in Casablanca (6 'Big Data' courses out of the 7 analyzed) (see Graph2).

The concentration of Big Data programs in cities such as Casablanca and Rabat reflects the strong demand for data professionals in these urban centers. These metropolises play a key role as economic and administrative hubs, home to a variety of industries and businesses that require skilled individuals to exploit data in the decision-making process. The availability of educational resources, internships and a dynamic job market make them attractive destinations for Big Data training programs, attracting both students and educational establishments. However, it is essential to monitor the equitable distribution of these programs across Morocco to ensure that Big Data education opportunities benefit aspiring students.

Graph 2 of the study offers valuable insights into the geographical distribution of these programs, helping students to plan their educational pathways based on accessibility and career prospects in their chosen cities. In addition, policymakers and institutions can use this information to address potential regional disparities in educational opportunities and promote workforce development in different regions of the country.



Graph 2. Distribution by City of the 26 "Big Data" Graduate Programs

The analysis of technical skills in Big Data (see Table 3) shows that there is a consistency between the requirements identified in the literature and graduate programs in Morocco, with minor disparities. Science faculties show high rates of skills related to mathematics, statistics, or algorithms because these institutions are historically known for their in-depth training in mathematical sciences, analysis, and modeling. Public engineering schools position themselves in data analysis, cloud computing, and big data systems because they schools have the laboratories and funding capacity to acquire high-performance computing machines.

Table 3. Technical Skills

Technical skills	Sources	Coverage rate		
		Public engineering schools	Privatesc hools	Science faculties
Programming skills	(Patil, 2011; Davenport & Patil, 2012; Davenport & Dyche, 2013; Miller 2014)	100%	100%	100%
Machine learning	(Conway 2010; Dhar 2013; Harris, Murphy & Vaisman, 2013; Miller,	92%	86%	100%

	2014)			
Statistics	(Conway, 2010, Dhar,2013; Miller,2014)	100%	86%	100%
Maths, algorithms	(Dhar, 2013 ;Miller,2014)	100%	100%	86%
Integration of traditional and Big data, real-time analysis and visualization	(Davenport & Dyche,2013 ; Davenport,2013)	92%	100%	86%
Predictive analysis	(Dhar, 2013 ; Miller,2014)	67%	14%	86%
Network analysis	(Dhar, 2013; Davenport,2013)	67%	14%	86%
Cloud computing	(Pinola, 2015)	83%	86%	86%
Operating system	(Pinola, 2015)	83%	100%	71%
Big data-systems	(Pinola, 2015)	92%	86%	86%

Source: authors.

For tools and technologies (see Table 4), the rates remain low for all courses, which can be explained by the positioning of each institution on one of the technologies, particularly for programming languages (Python, R, Java, C++). Similarly, these low rates may indicate to a problem with technical skills, which are limited to theoretical concepts without enabling learners to put all the skills they have acquired into practice.

Table 4. Tools and Technologies

Tools and technologies	**Sources**	**Coverage rate**		
		Public engineering schools	**Private schools**	**Science faculties**
Hadoop	(Conwey,2011 ; McAfee et al.,2012; Davenport,2013; Davenport & Dyche,2013)	33%	43%	43%

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R	(Davenport & Dyche, 2013)	17%	14%	43%
Python	(Davenport & Dyche, 2013)	25%	71%	100%
SQL and NoSQL	(Davenport & Dyche, 2013)	33%	57%	86%
Hive	(Davenport & Dyche, 2013)	0%	0%	0%
Excel	(Kiron et al., 2012)	0%	14%	0%
SAS	(Davenport & Dyche, 2013)	8%	0%	0%
IBM DB2	(Davenport & Dyche, 2013)	0%	29%	0%
Java	(Pinola, 2015)	33%	57%	57%
C++	(Pinola, 2015)	17%	29%	14%
Spark	(Pinola, 2015)	8%	14%	0%

Source: authors.

Finally, with regard to the professional skills identified in the literature and which can be

imparted in courses (see Table 5), we note perfect rates for public schools, since these establishments always include business and understanding of the professional environment in their courses, even imposing internships to validate the school year. On the other hand, we note a total lack of professional training at science faculties, apart from a few language and communication courses, confirming the hypothesis that training at these establishments is limited to theoretical aspects.

Table 5. Professional Skills

Professional skills	Sources	Coverage rate		
		Public engineering schools	Privateschools	Science faculties
Understanding management, decision management	(Waller & Fawcett, 2013; Provost & Fawcett, 2013; Miller, 2014)	83%	100%	29%
Reporting skills, documentation skills	(Davenport & Patil,2012 ;Davenport& Dyche,2013 ; Driest et al.,2016)	67%	43%	0%
Communication skills	(Davenport & Patil,2012 ; Chen et al.,2012)	83%	100%	29%
Agile methods	(Patil,2011)	58%	71%	0%
Change management	(Davenport & Dyche, 2013)	50%	14%	0%

Source: authors.

Discussion

The results of the empirical analysis provide a detailed view of the Big Data graduate programs in Morocco in 2022. Discussion of these results in relation to the existing literature highlights trends, similarities, and gaps that enrich our understanding of technical skills, tools and technologies, and professional skills taught in training programs.

In terms of technical skills, the results confirm the emphasis on programming skills, machine learning, and statistics, aligning training programs with the work of Patil (2011), Davenport & Patil (2012), and Miller (2014). However, some skills, such as predictive analytics and network analysis, are less widely taught, which could reflect specific market needs or implementation challenges. This suggests that these areas may require more attention in training programs. This could be due to specific labour market needs or challenges in implementing these skills. As a result, educational institutions could consider integrating more content related to these skills or implementing in place additional training to prepare students to meet the growing demands in these areas. Confirmation of these results highlights the importance of maintaining a constructive collaboration between the training offered and the needs of the constantly evolving market in the field of Big Data.

In terms of tools and technologies, Python is emerging as a dominant skill, reflecting its increasing adoption in the Big Data Analytics (Davenport & Dyche, 2013). Nevertheless, the use of certain tools such as Hive and Excel is notably low, perhaps due to the rapidly changing technological landscape and the move towards more advanced and flexible solutions.

In terms of professional skills, the discussion highlights the growing need for communication skills and an understanding of management and decision-making, linking to the work of Davenport & Patil (2012), and Miller (2014). However, skills in agile methods and change management are less present in programs, raising questions about the preparation of future Big

Data professionals for the challenges of project management and organizational transformation.

These results highlight the need for a balance between technical skills, tools and technologies, and professional skills to produce competent and adaptable Big Data professionals. Correlating these results with the literature reinforces the relevance of the skills identified and suggests areas for improvement in response to the constant changes in this rapidly evolving field.

The study by Ghanouane & Benkaraache (2022), focusing on IT recruitment agencies in Morocco, highlights the varied requirements for Big Data skills within companies. Of these, 84% of companies are looking for a moderate level of skills to perform advanced analysis, whereas only 42% require data scientists capable of designing innovative models. Preferred technical skills include coding, computational thinking, machine learning, and data mining. These findings complement our analysis of Big Data graduate programs in Morocco, confirming the importance of teaching technical skills to meet the needs of the evolving market.

Although this study has enabled us to explore in depth the technical skills, tools, and technologies as well as the professional skills taught in Big Data graduate programs in Morocco, it is important to note a significant limitation in the coverage of personal skills. The literature abounds with mentions of the importance of personal skills such as curiosity, associative thinking, creativity, and resilience in Big Data (Patil, 2011; Davenport & Patil, 2012). However, due to the nature of the program descriptions available, this study could not to comprehensively capture these personal skills.

Despite this limitation, this study offers significant insights into Big Data graduate programs in Morocco and the technical skills, tools and technologies, and professional skills that are taught. The discussion of these results with the literature reinforces our understanding of the challenges and opportunities of Big Data training in an ever-changing context.

CONCLUSIONS

This study has provided valuable insight into the Big Data graduate programs in Morocco in 2022. The in-depth analysis of the technical skills, tools, and technologies, as well as the professional skills taught in the training programs has provided a better understanding of how public engineering schools, private schools, and science faculties are preparing future Big Data professionals.

The results highlighted the importance placed on fundamental technical skills such as programming, machine learning, statistics, and mathematics, bringing training programs in line with the needs of the constantly evolving market. However, some skills, such as predictive analytics and network analysis, have been less widely taught and may need to be reviewed to better respond to emerging challenges.

The results also highlighted the dominance of certain tools and technologies, such as Python, while revealing disparities in the adoption of certain solutions, such as Hive and Excel. At the same time, professional skills such as communication and management understanding were identified as key elements, although skills in agile methods and change management showed lower coverage.

LIMITATION & FURTHER RESEARCH

Limitations

We acknowledge certain limitations in this study, notably the focus on 2022 and the absence of a real-time evaluation of the programs. However, this analysis offers significant insights into the supply of Big Data graduate programs in Morocco. By adopting this content analysis methodology, we are confident of the relevance and richness of the insights that this study will provide regarding the state of Big Data training provision in the country.

This study has limitations, particularly regarding the coverage of personal skills. Despite this limitation, the results provide a solid basis for continued reflection on the evolution of Big Data graduate programs in Morocco. Alternatively, a deeper understanding of these personal skills would require a more qualitative data collection methodology, such as interviews or surveys with educational supervisors and students. A qualitative survey would explore how programs encourage and develop these skills, and students' perceptions of them. Therefore, the current limitation of this study highlights the need for further research to address in depth the role of soft skills in preparing future Big Data professionals.

Further Research

Ultimately, this study contributes to the understanding of how Moroccan academic institutions meet the skills needs of the Big Data field. The findings provide insights into how to improve the alignment between graduate programs and market needs while offering perspectives for preparing future Big Data professionals who will successfully navigate a constantly changing environment.

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