Contents lists available at JBRI

Journal of Business Research and Insights

journal homepage: https://www.journals.sjp.ac.lk/JBRI

Article

Strategies in Developing Big Data Analytics Skills Among IT/BPM Professionals In Sri Lanka

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To link to this article: https://doi.org/ 10.31357/jbri.v11i01.8469

ARTICLE INFO

Article History:

Received *16.09.2024*
Revised *31.01.2025*
Accepted *10.03.2025*

Keywords:

Big Data
Big Data Analytics
IT/BPM Industry
Upskilling
Big Data Skills Gap

ABSTRACT

The growing adoption of big data has raised global concern over the skills shortage to meet its high demand, making Big Data Analytics (BDA) upskilling essential for professionals. The Information Technology/Business Process Management (IT/BPM) industry of Sri Lanka, major adopters of big data, are still in search for effective BDA upskilling mechanisms and strategies. Thus, the study aims to identify common BDA upskilling mechanisms and develop a process model to understand BDA upskilling in this industry. Research methodology employs a literature survey of BDA skills considering the skills categorization of the Katz skills framework for initial exploration of specific BDA skills and interviews with industry experts to achieve research objectives. Thematic analysis of collected data revealed research findings as the critical need to upskill for BDA, highlighting the local BDA skills gap and identifying major mechanisms like expert sessions, training courses, challenges, collaborative and practical engagement, supported by incentives, resources, and a learning culture. The process model developed from the findings suggests a systematic approach to BDA upskilling, considering technical, conceptual, and human skills through a continuous sequential process from skills specification to skills identification, implementing upskilling mechanisms and BDA skills gap identification. Research outcomes also recommend frequently updating, improving mechanisms and aligning them with employee needs when upskilling for BDA. The study underscores BDA skills development among Sri Lankan IT/BPM professionals and contributes to local and global BDA skills enhancement, addressing the awareness and literature gap in big data. Limitations direct future research to consider larger sample sizes and explore challenges and integration with advanced technologies for BDA upskilling.

To cite this article:Nanayakkara, N.S.A.D. and Fernando, W.M.N. (2025) Strategies in developing big data analytics skills among IT/BPM Professionals in Sri Lanka, Journal of Business Research and Insight, 11:01, 43-66, DOI: https://doi.org/ 10.31357/jbri.v11i01.8469

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Introduction

Rapid technological advancements are largely caused by massive amounts of data being generated by various sources such as sensors, computers, Global Positioning Systems (GPS) and mobile phones as online interactions of people keep growing (Lasanthika & Wickramasinghe, 2020; Belias et al., 2021), uprising an era of Big Data (Reddy & Singh, 2015).

The term "Big Data" is characterized by the 3Vs, 'volume, velocity, and variety' explained as data existing in large sizes, forms and generated rapidly from multiple sources (Laney, 2001) where value from this data is generated only by analyzing and not merely by collecting or storage (Watson, 2014). Accordingly. Big Data Analytics (BDA) is defined as a set of techniques focused on gaining actionable insight to make smart informed decisions from vast amounts of data (Duan & Xu, 2021).

Today, the complexity of Big Data (BD) is beyond the capacity of traditional data analysis techniques and tools due to which organizations must prepare for a change of skills, leadership, organizational structures and other organizational aspects as they join the data economy to maintain competitive advantage in the market (Lasanthika & Wickramasinghe, 2020). Studies have shown that companies that have adopted data-driven decision making have 5% to 6% higher output and productivity than other companies (Watson, 2014). However, the World Economic Forum reported that the growing demand for big data analytics is contrasting with the lack of skills among the current professionals for BDA (Forum, 2023).

The study focuses on Sri Lanka's IT/BPM industry to investigate the BDA skills gap. The IT/BPM industry broadly referred to as the 'outsourcing industry', is the fifth highest foreign revenue earner for Sri Lanka as of 2020 (Abeywickrama et al., 2020a). Recognized as Sri Lanka's industry of the future, IT/BPM industry has predicted to reach an expected revenue of US$5 Billion and consequently doubled the demand of workforce by 2025 (SLASSCOM, 2020). Employability skills survey done by SLASSCOM in 2021 revealed that the big data related skills are to drive skills demand in the future with analytics and big data platforms and applications trending at 67% in the BPM sector whereas the ICT sector increments 61% and 43% respectively (SLASSCOM, 2021). Yet, the skills gap challenges the industry requiring attention on skill types, quality and levels and volumes (Abeywickrama et al., 2020b).

The Tertiary and Vocational Education Commission (TVEC, 2021) elaborated data analytics as the biggest skills gap area for IT departments globally which will cost employers up to 416 hours and over $22,000 per employee, per year. Yet, fewer than 60% of employers offer formal training for technical employees (TVEC, 2021). The latest employability survey done by SLASSCOM revealed that 95% of employers in the IT industry are facing the challenge of finding employees with the right technical skills (SLASSCOM, 2024). The International Labor Organization in developing a way forward for Sri Lanka recommends focusing efforts on skilling/reskilling/upskilling for jobs in data science and analysis since the IT industry's skilled labor shortage can lead to significant job loss and redundancy (ILO, 2019).

Several Sri Lankan organizations have recognized the value of big data and initiated upskilling efforts, such as the Data Science Academy by Dialog Enterprise, OREL Academy by OREL IT, and KPMG's training programs. However, BDA skills development still falls short of meeting the growing demand (Dancs et al., 2024).

Problem Statement

Big data analytics professionals are in high demand as organizations are improvingly becoming data-driven yet found short of supply professionals with appropriate analytics skills (Shirani A., 2019; Nurlan, 2022; Forum, 2023). This demand has been identified as the "next big wave for talent" exclaiming the increase in production and use of data in businesses causing higher demand for personnel trained in various data and analytics disciplines (Shirani A., 2019). Nurlan (2022) states that being data-driven requires skills beyond traditional technical skills to maximize value from data and there is an accruing demand for data related positions and skills as confirmed by the World Economic Forum (Forum, 2023). The huge demand for BDA skills conflicting with the supply for it causes a skills gap focusing attention on skills development for big data professionals. The Export Development Board (EDB) of Sri Lanka promotes the IT/BPM industry as a pioneering adopter of BDA

equipped with a skilled workforce (SLASSCOM, 2020), yet literature found the lack, relevance and quality of training programs, lack of qualified individuals, skills emigration, industry-academia mismatch, organizational challenges and local policies causing a BDA skills gap (ICTA, 2019; Chandrasiri & Gunatilaka, 2015; Dancs et al., 2024). Studies such as by Shirani A. (2019) and Li (2022) have emphasized the requirement for up-skilling and re-skilling of employees for BDA skills. However, IT/BPM companies in Sri Lanka are still in search for effective mechanisms and strategies to develop BDA skills of their employees (Abeywickrama et al., 2020a; Dancs et al., 2024; Gishanthi et al., 2023).

Research Objectives

The research study aims to achieve the following objectives.

- To identify mechanisms employed by IT/BPM companies in Sri Lanka to develop Big Data Analytics skills of their existing workforce.
- To develop a skills upgrade process model to how IT/BPM companies in Sri Lanka develop Big Data Analytics skills within their workforce.

Literature Review

Big data in its' early stages was defined by the 3V model (Davidavicienė et al., 2020), but more recent studies have expanded it to 5Vs or 7Vs, including properties, veracity, value, validity, visibility, venue, vocabulary and vagueness (Davidavicienė et al., 2020; Chao & Lai, 2015). Big data market forecasts predicted that the global data creation is to surpass 180 zettabytes by 2025, a growth accelerated than expected by the post-COVID-19 shift to online platforms (Taylor P., 2023). According to the forecast, the global big data market growth expected to reach $103 billion revenue by 2027 (Taylor P., 2024).

Researchers defined 'BDA' as a process of analyzing large datasets to discover patterns, relationships and other important information (Bowers et al., 2019) and is also one of the nine pillars of Industry 4.0 (I4.0) technologies (Dancs et al., 2024). McKinsey Global Institute predicts the year 2025 is a year of data-driven enterprises where most employees will use data to optimize nearly every aspect of work, fostering a data-driven culture that boosts performance and the first step is to upskill employees for data and Artificial Intelligence (AI) (Assur & Rowshankish, 2022). The McKinsey survey stated in Neil Assur, K. R. (2022) also highlighted that a 20% enterprise growth opportunity in data and analytics is only if enterprises are truly data-driven, with big data as a key competitive factor.

DECAS, a recent theoretical development introduced a data-driven decision-making theory that big data and analytics(machine) should be considered as separate elements (Elgendy et al., 2022). Since organizations increasingly move from human decision making to fully automated processes, this collaboration of the decision-maker (human) and analytics(machine) shall result in a collaborative rationality beyond classical decision making leading to more informed, better decisions (Elgendy et al., 2022). For instance, a case study of "DigiLocker" in India showcases data analytics that inform their policy decisions and resource allocation (Bhattacharya, 2023).

A 'skill' of an employee is defined as domain specific expertise gained through education, training or experience (Shirani A., 2019). Alternatively, the same defined as the employee's ability to perform some behavioral task (Katz, 1955). The BDA field encompasses ever-evolving skills with multiple disciplines ranging from statistics to data and information management, data visualization, understanding the frameworks and programming languages (Shirani A., 2016).

The "T-shaped" theoretical model is a notable skills configuration for IT professionals representing breadth of skills as the top part of the letter "T" and depth in the vertical part (Shirani A., 2016). For example, it may indicate core data analytics knowledge and competencies accompanied with deep expertise in an analytics sub-field or functional area or both underscoring the importance of the ability to apply knowledge and skills in a broader context.

A study by Gupta and George, 2016 (as cited in Davidavicienė et al., 2020) identified two skills categories for data analytics,

- Technical Skills – Technical know-how and the ability to extract valuable insights from data. i.e. Ability to work with big data processes like data extraction and data cleaning, competencies in machine learning and programming paradigms such as MapReduce.
- Managerial Skills – Related to the organization's management, understanding where and how to apply extracted insights from big data and ability to predict current and future organizational needs.

With an investigation of analytical skills that should be developed among future professionals in data science, and big data analytics, Shirani A. (2016) prioritized a set of skills/knowledge categories ranging from foundational, intermediary to advanced levels such as:

- Foundational skills/background: knowledge and experience in Statistics, Mathematics, Computer programming.
- Specific data analytics skills: data mining skills with R, SQL, Python, C, and Java programing, and quantitative skills in general.
- Big data skills: knowledge and experience in Hadoop and Spark frameworks
- Soft skills: personal, inter-personal, and teamwork abilities such as drive, insightfulness, problem-solving, communication, and people skills.

Shirani A. (2016) also added that these skill sets are acquired through good domain knowledge, solid mathematics and statistics background, and by working in teams.

Gishanthi et al. (2023) states that 60% of organizations demand the ability to accurately interpret and communicate results by Big Data Professionals (BDP) at the basic level. Analytical and problem-solving skills, communication, and teamwork are also top skills that employers seek from new graduate hires according to the SLASSCOM 2024 skills survey. While specific skills may vary across studies, big data analysts are expected to possess both technical and non-technical skills, along with domain knowledge (Peterson T., 2004), beyond traditional capabilities (McAfee & Brynjolfsson, 2012) to ensure efficient decision-making and predictions (Bowers et al., 2019). According to the World Economic Forum, data analysts, scientists and big data specialists are amongst the top 10 fastest growing jobs – 65% positive impact and places big data as the 3rd prioritized skill out of the top 10 by businesses for 2027 (Forum, 2023).

The skills gap among professionals refers to the gap between workplace demand and the skills supply (Shirani A., 2016). Data management and analytics skills has been a rising concern considering impactful global events like the European Union's General Data Protection Regulation, Brexit worsening the supply chain crisis (Foster, 2022) and the Covid-19 outburst (Gishanthi et al., 2023). Many studies stressed the importance of BDA to manage those global events. Key causes for this BDA skills gap discovered as the difficulty to gain clarity on the specific skillset since such set of skills evolve with technology progressions (Shirani A., 2016), and non-existence of approved standards to define data-related positions (Nurlan, 2022). On the contrary, this gap also presents an opportunity for digital transformation and economic growth (Mohan et al., 2022).

The Harvard Business Review identified the shortage of people with big data analytical skills as a major challenge of businesses adopting big data (McAfee & Brynjolfsson, 2012). The Forum (2023) presents that skills and talent gaps block industry transformation and that 81% of organizations plan on investing in learning and training on the job as a workforce strategy for the period 2023 – 2027.

Studies in this domain use terms as skilling, reskilling and upskilling interchangeably to mean an acquisition of a higher level of knowledge and skills (Shirani A., 2019) either to advance within the current job responsibility or to take on different or newer roles (Li, 2022). Terms such as training/retraining have also been used in such research to refer to the similar meaning. In the current work patterns which organizations increasingly utilize digital technologies and remote work, 84% of employers around the world encouraged their employees to learn digital skills like BDA. Innovative teaching methodologies for practicality, flexibility and context-specific learning experience is imperative for upskilling in the IT sector since traditional mechanisms maybe insufficient in the rapidly changing landscape (Ajayi & Udeh, 2024).

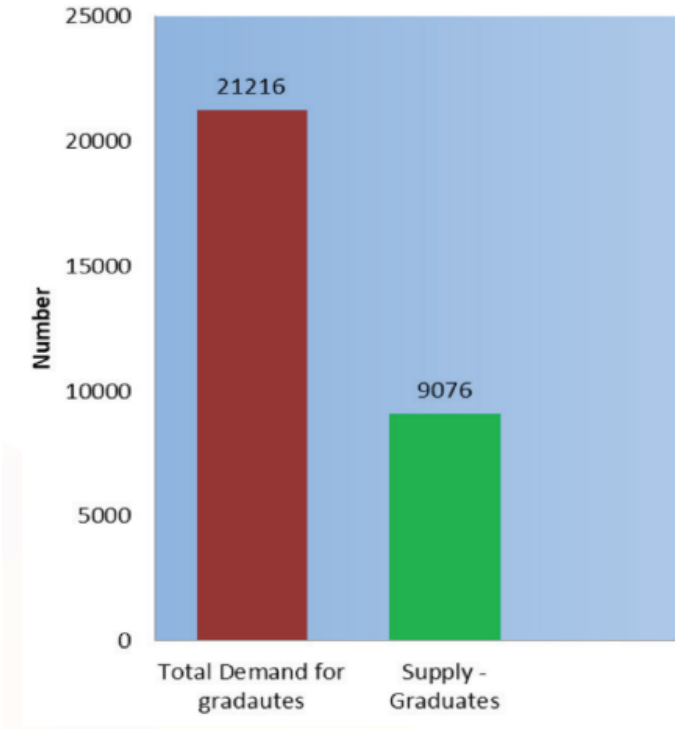
Investing in upskilling for BDA benefits both employees (through professional development, job satisfaction and improved career prospects) and employers (through increased productivity, innovation, employee retention leading to increased organizational competitiveness and resilience) (Ajayi & Udeh, 2024). However, challenges like skill identification difficulties, ensuring accessibility and quality of training programs and in fostering a learning culture within the organization are inevitable (Ajayi & Udeh, 2024).

Sri Lanka's IT/BPM industry consists of an ICT workforce in both ICT companies catering to local and global demand and BPM companies catering to the demand for ICT-enabled services from several industry verticals of global value chains, gaining recognition as one of the six priority sectors in the National Export Strategy (NES) with their impressive export performance. 85% of the US$ 995 million earnings from the export of telecommunication, computer and

information services in 2018 is accredited to joint earnings by ICT and BPM companies (ICTA, 2019). According to the Export Development Board (EDB), Sri Lanka's IT/BPM industry has grown over 300% over the last 10 years, reaching a US$ 1.2 billion revenue, providing jobs to over 80,000 professionals and contributing to 12% of Sri Lanka service exports. This industry consists of large adopters and providers of big data solutions and data management services including industry giants such as Orel IT, Virtusa, Axiata Digital Labs, IFS, H-Connect, Hayleys Business Solutions, Innodata, KPMG and Wiley Global Technology as mentioned in the EDB website, Sri Lanka (EDB, n.d.).

Regardless of limited literature, Dancs et al. (2024) emphasizes that South Asian countries including Sri Lanka isn't ready for I4.0 technology adoption and requires investment in skill development, Gishanthi et al. (2023) identified the BDA shortage in the country's logistics industry highlighting the need to extend systematic competency development programs for local employees for continuous skill enhancement, along with appropriate remuneration.

Figure 1. Demand and Supply of ICT graduates in Sri Lanka 2019



Source: ICTA (2019)

According to ICTA (2019), the total demand for emerging technologies was estimated at 5,323. Of the total demand for emerging technologies, a substantial share (76.6%) originates from ICT companies. Of the emerging technologies, big data platforms and processing takes 9.5% of demand ranking at 5th position. Data analysis ranked the 2nd highest service line for BPM workforce demand and the topmost prioritized technical skill in demand for BPM workforce. Overall, soft skills such as communication, teamwork, creative thinking skills are important for BDA and are also in-demand skills for ICT workforce in the country. However, there is a widening gap between demand and supply of skills for the ICT workforce in the country due to asymmetric growth in demand (ICTA, 2019) (Fig 1).

The report further states that despite the output of many trainees from training organizations offering several courses, the quality of a significant share of them remains below employer expectations.

The ICTA (2019) has pointed out upskilling priorities of the largest number of organizations as follows:

Table 1. Means of Skill Development for Career Advancement

Employer Category	Means of Skill Development for Career Advancement		
	Priority Rank 1	Priority Rank 2	Priority Rank 3
ICT Companies	Academic qualifications	Professional qualifications	Formal in-house training courses
BPM Companies	On the job training	Professional qualifications	BPM-related trade certification

Source: ICTA (2019)

Based on the available literature, formal in-house training courses are the 3rd priority of many organizations while employee qualifications were prioritized over actual upskilling or BDA upskilling (ICTA, 2019). The reported statistics highlights the insufficiency of upskilling mechanisms in the IT/BPM industry of Sri Lanka.

The ICTA report (2019) further explains incentives as a form of employee retention and a summary of incentives offered are as follows:

Table 2. ICT Workforce Incentives

Level of Experience	ICT Companies	BPM Companies
Up to 1 year	Training	Training

1 to 3 years	Challenging Job	Good career path
3 to 8 years	Oversees exposure visit	Good compensation plan
8 to 12 years	Good employer – employee relationship	Company stability
Over 12 years	Medical Insurance	Job security

Source: ICTA (2019)

However, the survey does not present incentive alignment with employee needs underpinning a mismatch between incentives and employee needs and expectations. Additionally, infrequent surveying (ICTA, 2019) reveals the lack of local knowledge on BDA upskilling requirements.

The skills framework by Robert Katz introduces a three-category typology of managerial skills (Katz, 1955; Peterson & Van Fleet, 2004; Dierendonck & Schmidt, 2023) as,

- Technical skills: Expertise in tasks involving the use of specialized tools, methods, processes, procedures, techniques, or knowledge. Essentially, skills required to work with things not people.
- Human skills: Skills primarily concerned with people such as collaboration, cooperation, effective communication, conflict resolution, and teamwork.
- Conceptual skills: The ability to see the organization as a whole or to have a systemic viewpoint. This focuses on ideas and concepts not on things nor people.

These skills are interrelated when applied practically and a different mix of these skills are required at each managerial level of an organization – human skills are equally important at each organizational level, technical skills are more important at the lower level and conceptual skills at the top level (Dierendonck & Schmidt, 2023).

Every individual regardless of their organizational position must possess these 3 broad categories of skills as they move to higher managerial roles (Peterson & Van Fleet, 2004). Although evolutionary changes have been made to the framework, it remains the foundation for other evolutionary models, validating the model's applicability in modern context (Dierendonck & Schmidt, 2023).

Systematic BDA upskilling has been explained as a continuous process collaborating amongst several decision makers and functional areas underscoring the multifaceted nature of skills gaps in emerging IT technologies requiring this multi-stakeholder approach to ensure skills alignment with organizational goals and must occur by translating the organization's goals to the skills and competencies the organization needs to achieve those goals, inventorying employees' skills and finally upskilling employees supported with necessary resources and incentives (Shirani A., 2019; Ajayi & Udeh, 2024).

Davidavicienė et al. (2020) produces a conceptual framework for a continuous learning process to execute successful big data projects which follows from skills identification to identify skills gap comparing the skills required for the project/job with the employee's skills, preparing training plan, revising employee profiles to assess their competencies and executing upskilling mechanisms for technical and soft skills development, attentive of individuals/groups for specific skill gaps.

The experiential learning theory by Kolb (as cited in Ajayi & Udeh, 2024) bases designing upskilling programs accommodating diverse learning styles while ensuring informativeness, engagement and accessibility of training methodologies.

Upskilling initiatives for emerging technologies found flexible learning models, industry-academia partnerships (Ajayi & Udeh, 2024) and solutions specific to big data like e-learning, mentoring, in house sessions, generic courses and external training solutions such as conferences and seminars emphasizing the importance of employee motivation through incentives as well as a continuous learning culture within the organization (Davidavicienė et al., 2020). Notable upskilling trends direct personalized learning employing data analytics to tailor content and pacing to the individual learner to address specific skill gaps (Ajayi & Udeh, 2024). Human interaction is also placed of importance underscoring a balanced approach to upskilling combining technology with personalized support (Ajayi & Udeh, 2024).

Rapidly emerging technologies such as AI, cybersecurity, cloud computing (CC) and Internet of Things (IoT) necessitate continuous learning for IT professionals (Dancs et al., 2024; Ajayi & Udeh, 2024). For instance, a case study of Google attributes a variety of workforce upskilling initiatives for tech and innovation including internal learning platforms like "Google University" and "Googler-to-Googler,"

technical training programs on areas like AI, CC and Machine Learning (ML), soft skills development courses and certifications that have earned Google high employee retention rates with adaptable top-skilled employees (Bhattacharya, 2023).

A study conducted in Malaysia for upskilling for the 4th Industrial Revolution (IR 4.0) identified the creation of a digital culture along with effective training for I4.0 technologies including BDA and government backing; however, their lack of internal expertise was noted therefore relying on external partners for upskilling and even company merges and acquisitions for competencies (Wahab et al., 2021). In similar sight, Dancs and colleagues (2024) claims the dominant skills gap for BDA and other I4.0 technologies in South Asian countries like Sri Lanka, India and Bangladesh. They suggested the need for upskilling and reskilling through mechanisms of creating a learning environment, industry–academic collaboration, infrastructure development, knowledge sharing and transfer internally and externally, and reforming education with enhanced training curricula.

While there is progressive adoption of big data technology in Sri Lanka, there is still a shortage of big data professionals (Gishanthi et al., 2023). In Sri Lanka, educational factors impacting BDA skills development found accreditation programs, crash courses such as Coursera and qualifications higher in number and of better standardization internationally unlike locally which is adversely impacting the employability of local BDP (Gishanthi et al., 2023). The current education system in Sri Lanka is also falling behind in preparing students for specific technological advancements (Abeywickrama et al., 2020b). According to the ICTA (2019), the training system of ICT graduates has not been geared in a sufficient scale and some in-demand skills from employers are not supplied by training organizations and vice versa causing the industry-academia mismatch. For example, business analysis, a highest in-demand skill is not in the top list of skills offered by training organizations (ICTA, 2019).

This shortage is also driven by factors such as data-related infrastructure capabilities, data management challenges, privacy and security, market pressure and big data pressure impacting intent to adopt BDA by organizations; and the local IT/BPM industry struggle due to skills migration, brain drain to foreign nations, outdated policies and absence of flexible labor laws. (Bolonne & Wijewardene, 2020; Abeywickrama et al., 2020a). While many of the studies mention the requirement of BDA skills development, hardly any study found in the Sri Lankan context discuss proper assessment of the mechanisms and strategies employed by IT/BPM companies to develop BDA skills among employees.

Research Methodology

We believe that utilizing information from the BDA workforce of IT/BPM companies in Sri Lanka we can identify BDA upskilling mechanisms. Then develop a BDA skills upgrade process model. With this belief, we proceeded with this methodology.

The research onion by Saunders (Bristow et al., 2009) guided the methodology of this study. The undertaken qualitative research approach, open-ended in nature, suited the study as it pertains to the objective of the study to gain an in-depth understanding of BDA skills development among IT/BPM professionals in Sri Lanka via an understanding of perceptions, experiences and attitudes of individuals and organizations that are difficult to quantify.

The qualitative approach enabled inductive reasoning, a signature element of qualitative research (Boswell et al., 2022). Inductive reasoning occurs since the study moves from specific to general proposition where the study collects specific data, analyzes them to provide generalized findings that are representative of the people outside the sample. The study is based on the interpretivism philosophy which is linked with qualitative research described as reality being subjective, multiple and constructed of social opinion (Boswell et al., 2022).

Data Collection Approach

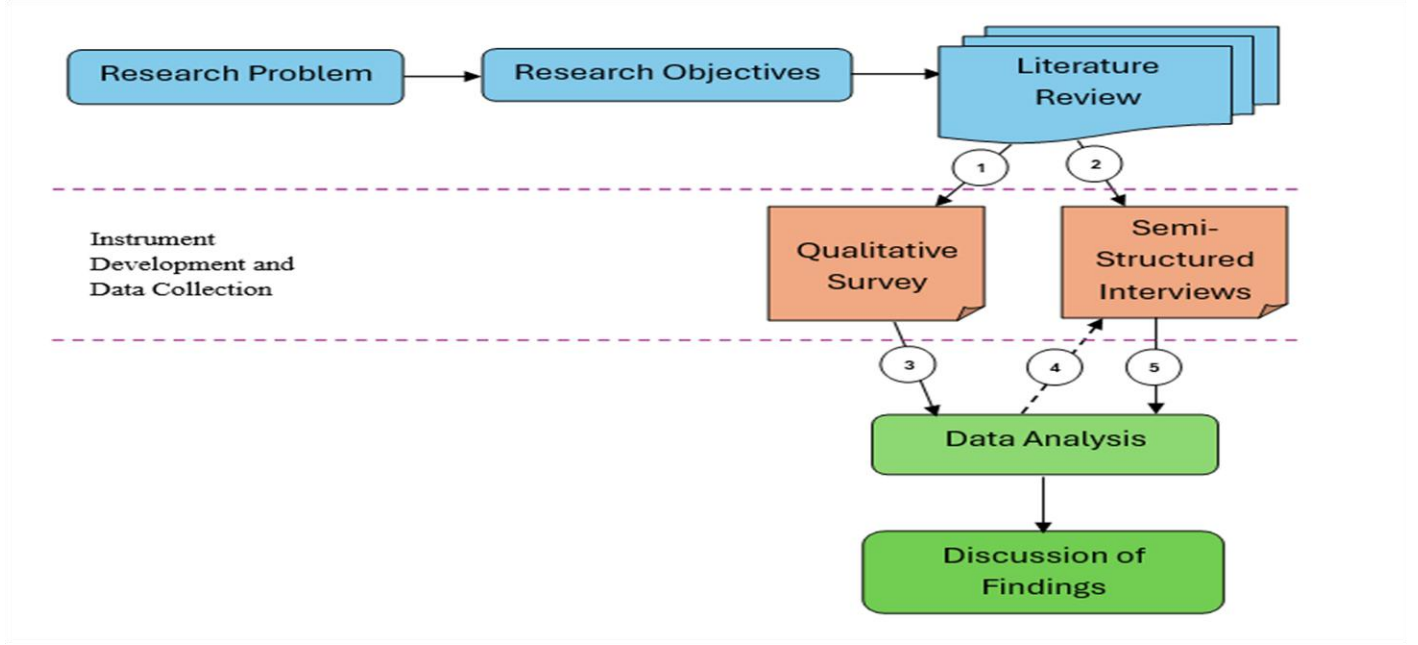
The study comprises of two data collection methods, namely a qualitative survey and interviews with BDA experts in a cross-sectional approach, where the information was gathered at a particular point in time to gather qualitative primary data.

The research study was conducted in order of activities depicted in Figure 2. Based on the research gaps identified and the objectives defined in the beginning of the study, empirical research findings from the literature review such as theoretical frameworks, skills upgrade models and various upskilling mechanisms were analysis to identify professional skills based on the skills model by Katz (Katz, 1955) that classified managerial skills as technical, conceptual and human skills. The skills identified from the literature were also categories to obtain specific BDA skills per each category in the Katz skills model. In order to contextualize the BDA skills, an open-ended qualitative survey was conducted among BDA experts

identified from the IT/BPM industry. The survey was used as an initial exploration of specific BDA skills to be upskilled in IT/BPM companies in Sri Lanka. The survey tool contained open ended questions to obtain clear answers about the BDA skills relevant to IT/ BPM companies in Sri Lanka. Qualitative survey was developed as a Google Form and distributed online with IT/BPM professionals' expertise in big data analytics regardless of their organizational position.

The data collected from the qualitative survey was then analyzed to develop questions to be asked in the semi structured interview with the consideration of literature review definitions of BDA skills, upskilling mechanisms and models. Semi-structured interviews were conducted to identify BDA upskilling mechanisms and understand BDA upskilling among IT/BPM professionals in Sri Lanka. The semi-structured nature provided flexibility in achieving research purpose by making changes in the questions to gather the required information without deviating from the scope of study.

Figure 2. Research Outline



Prior to conducting interviews, a consent form along with an information sheet containing all relevant details regarding the interview like researcher's details, research purpose, participant's expected contribution to the study, confidentiality policy, and other related details along with a summary of the questions to be asked in the interview was shared with the research participant after initially contacting the participant via LinkedIn.

Interviews were conducted and recorded online via the Zoom platform with big data professionals across different organizational levels in IT/BPM companies of Sri Lanka and each interview was conducted for approximately 30 minutes. The participants suited to the study since they possess both the required BDA technical knowledge and human resources management related knowledge in terms of upskilling employees for BDA.

Respondents for both data collection methods were selected by approaching them via LinkedIn and their biographies were reviewed prior to selection to ensure suitability. It was ensured that they were IT/BPM professionals in Sri Lanka specializing/related to the big data field. Search keywords consisted of IT/BPM company names listed in the EDB website of Sri Lanka or terms such as "data analyst", "big data analyst" or "data engineer".

Population and Sample

The target population included all professionals in the field of big data in IT/BPM companies in Sri Lanka. These professions considered titles such as big data analysts, data architects, data scientists and data engineers (Gishanthi et al., 2023) across different organizational levels since these terms are often used as umbrella terms (Shirani A., 2016) and skillsets are somewhat similar (Shirani A., 2019).

In qualitative studies, the sample size decided based on saturation, the point where further data collection does not result in any more new information (Daniela, 2020). Accordingly, this study reached saturation point with 8 interviewees and 10 survey respondents to achieve the research objectives. The unit of analysis for each method was individual IT/BPM professionals in big

data.

We used convenience sampling technique, a non-probability sampling technique as it is simple, efficient, makes the study more viable and allows choosing participants representative of the required characteristics and defined population (Luborsky & Rubinstein, 1995).

Data Analysis Approach

The data gathered using qualitative survey and interviews was transcribed and analyzed via a thematic analysis, a data analysis technique that identifies themes in the collected qualitative data. The thematic analysis followed a series of steps as explained by Braun and Clarke (2006): familiarize oneself with the data to gain an understanding of the transcribed data collected before analyzing, read and re-read, generate initial codes by applying labels to portions of text and coding them, search for themes, review the themes to ensure they represent the data accurately, define and name themes and finally produce the research report (Braun & Clarke, 2006).

The QDA Miner Lite software application was used for the analysis to achieve high results accuracy.

To analyze the data gathered from the survey, a frequency analysis was conducted using the QDA Miner Lite software to identify the number of times a term appears under themes coded as each skill category. This analyzed data was then ranked in order using the MS Excel software application for better understanding of the results.

Results & Discussion

The data collection concluded with 10 survey responses and 8 interviews. The low response rate for the survey is due to the exploratory nature of the data collection approach.

Descriptive Data Analysis

Survey responses coded under the 3 main skills categories is analysed below in terms of the frequency of each skill per category and their priority ranking, identifying the most common BDA specific skills.

Table 3. BDA Skills analyzed via survey data

	Technical Skills	
Skill Name	**Frequency/Nb Hits**	**Percentage**
Python	10	50.0%
Hadoop, Apache, Power BI, Machine Learning	4	20.0%
SQL, Cloud Services, R	3	15.0%
Tableau, Data preprocessing, Data modelling, DBM, Data warehousing	2	10.0%
MS Excel, VBA, Data mining, Data quality Analysis, ETL, Statistical analysis, Java	1	5.0%
Total	20	100%
	Conceptual Skills	
Creative Problem Solving	5	45.5%
Analytical Skills/Logical Reasoning	3	27.2%
Data Visualization, Data Interpretation/floor of data, Critical thinking, Strategic planning, Communication	2	18.2%
Ability to see overall big picture, Data Modeling, Statistical Analysis, Adaptability, Interpretation, Systems Thinking, Entrepreneurial Thinking, Futuring, Visioning, Systems Optimization, Change Management, Project Management, Decision Making	1	9.1%
Total	11	100%

	Human Skills	
Teamwork, Communication, Motivation/Resilience	10	27.8%
Dealing with conflict	8	22.2%
Interpersonal Relations/Networking	6	16.7%
Creating organizational climate	5	13.8%
Sensitivity/Emotional Intelligence	4	11.1%
Time Management/Timeliness, Friendly, Adaptability, Active Listening/Understanding People Behavior	2	5.6%
Leadership, persuasion	1	2.8%
Total	36	100%
Theoretical/ Domain Knowledge	3	30.0%
Total Respondents	10	

Thethematic analysis conducted for the interview data revealed the following themes, codes and example excerpts from the transcripts are summarized below.

Table 4. Themes, Codes and Example Excerpts

Category/Themes	Codes	Excerpts
1. BD/BDA Value	Demand	"Big data is one of the most important things within companies"
	Data-driven	"Big data is of big important value, our business decisions, day-to-day operational decision making all depends on this data."
2.Further Action	Update	"Technology or the skill gap needs to be analyzed at least quarterly to keep the employee up to date."
	Requirement Alignment	"When giving targets or incentives, should also think about our mental and physical capabilities."
	Expansion	"If you are willing to spend more, you can give colleagues training from outside Sri Lanka."
3.Main Techniques	Challenges	"Like bi-yearly, we do a hacker case in the business."
	Expert Sessions	"Our CEOs and operating managers come from abroad and they teach us."
	Training Courses	"In this program, we track different skillset of our analysts like SQL, python and visualization."
	Collaborative Engagements	"This is sort of like open auditorium. Basically, everybody can join, leave, but you can get something by listening to tech *conversations.*"
	Practical Engagement	"The exposure we have gained from the company while handling data and doing analysis is very important"
4.Industry Alignment	Knowledge Sharing	"We do cross functional trainings to make sure that people have at least an understanding regarding even with the operations, the technical terms within data analysis"

	Industry Standards	"How you secure data, access data more secure manner, master data for the particular audience… Those things can be changed over time, based on requirements and industry standards."
	Regulations	"The higher ups when they are planning and implementing these changes, they are aware of these international laws. And they are aligning their training methods and what the changes are, according to those"
5.Skills Gap Assessment	Formal Evaluations	"Based on annual reviews also we are monitoring whether they need some improvement and whether they are in appreciable level of knowledge"
	Change Monitoring	"Anytime, even a small change happens, higher up people come to our office, and they thoroughly train us to prepare for these big data challenges"
	Monitoring Based	"Each employee has a supervisor so supervisor will closely monitor about skills of their direct reports and have some formal and informal chats"
6.Skills Identification	Interviews	"...In the interview process and ask some related theories and methods in data analysis and data science"
	Case Studies	"We will give some case, and they will like explore that from the given dataset and do some analysis"
	Mini Assessments	"We give them IQ tests, pattern, identifying tests, writing tests, to identify whether this person fits our company, can crunch the data, can handle these big data related activities."
7.Supportive Techniques	Monetary Incentives	"Since they passed it, they will receive an incentive that will encourage them to do that right. Without any motivation, people don't do it."
	Resources	"We are giving you the free materials, the e-learning system to practice"
	Learning Culture	"They always support, mentor, enhance my knowledge and skills."
8.Upskilling Process	Recurrent	"These are the courses which runs yearly."
	Sequential	"First, supervisor will see how he can help the team to fill this gap. Secondly, what are the trainings that needs to be provided to the teammates"

9.Skills Specification	Job Description	"Whenever we do hire, we have a job description. It will specifically say these are the skills that you need to have"
	Business Requirement	"Business problem is identified first and then there will be a solution defined as well, to fill the gap between them, people are hired like that"
	Data Strategy	"What is company's AI and data strategy going to be? That is where we identify the skills required."
10.Upskilling Value	Competition	"They are really helping us to make a very competent employee in this field by their programs"
	Growth and Development	"We had those experts, and they guide us towards achieving the goals and our personal developments as well."
	Satisfaction	"...we get a value for ourselves inside the company"
11. BDA Skills Gap	Human Resource	"The gap that I see here, people are tool oriented, specific language oriented. He might not know how to break down, how to join his piece of work to get the solution."
	Quality	"Most companies have been using the same strategies"

Frequency of the codes generated through the QDA Miner Lite software is summarized below,

Table 5. Transcript Code Frequencies

Category	Code	Description	Count	% Codes	Cases	% Cases
BD/BDA Value	Demand	Demand for Big Data and relevant skills locally and internationally.	7	5.10%	4	50.00%
	Data-driven	Data-driven organization that makes use of big data for day-to-day operations and decision-making.	4	2.90%	3	37.50%
Further Action	Update	Frequent analysis of upskilling mechanisms, skills, skills gaps and technology to remain updated.	2	1.40%	2	25.00%
	Requirement Alignment	Upskilling must align with employee needs.	4	2.90%	4	50.00%
	Expansion	Improve existing upskilling mechanisms.	1	0.70%	1	12.50%
Main Techniques	Challenges	Challenging Activities	1	0.70%	1	12.50%
	Expert Sessions	External training methods	6	4.30%	6	75.00%
	Training Courses	General or Company developed BDA coursework.	7	5.10%	5	62.50%

	Collaborative Engagements	Internal training methods	10	7.20%	4	50.00%
	Practical Engagement	Learning through actual involvement in data-related tasks.	3	2.20%	2	25.00%
Industry Alignment	Knowledge Sharing	Enhance employee knowledge on evolving industry needs by sharing knowledge.	4	2.90%	2	25.00%
	Industry Standards	Update organizational strategies, goals based on industrial standards for BD.	3	2.20%	3	37.50%
	Regulations	Update organizational strategies, goals based on government regulations for data.	2	1.40%	2	25.00%
Skills Gap Assessment	Formal Evaluations	Formal reviews	4	2.90%	4	50.00%
	Change Monitoring	BDA skills upgrading whenever a change occurs.	1	0.70%	1	12.50%
	Monitoring Based	Close supervision to identify BDA skills gaps.	5	3.60%	5	62.50%
Skills Identification	Interviews		4	2.90%	4	50.00%
	Case Studies		1	0.70%	1	12.50%
	Mini Assessments	IQ tests, Analytical tests…etc.	4	2.90%	4	50.00%
Supportive Techniques	Monetary Incentives		8	5.80%	6	75.00%
	Resources	Study material, LMS…etc.	3	2.20%	3	37.50%
	Learning Culture	Encouraging continuous learning for BD.	6	4.30%	4	50.00%
Upskilling Process	Recurrent	BDA skills development as a continuous process.	5	3.60%	3	37.50%
	Sequential	Step-by-step flow of the BDA skills development process.	10	7.20%	4	50.00%
Skills Specification	Job Description	JD as a tool specifying BDA skills.	2	1.40%	1	12.50%
	Business Requirement	Specification based on business/project requirements.	1	0.70%	1	12.50%
	Data Strategy	Specification based on initial organizational data strategy.	1	0.70%	1	12.50%
Upskilling Value	Competition	Competitive workforce and organization.	2	1.40%	2	25.00%
	Growth and Development	Personal and professional development of employees.	6	4.30%	4	50.00%
	Satisfaction	Employees feel valued within the organization.	1	0.70%	1	12.50%

BDA Skills Gap	Human Resource	Less people, knowledge, skills plus recent adoption of BD and lack of awareness.	10	7.20%	5	62.50%
	Quality	Generalized BDA upskilling mechanisms, mismatch between employer and employee needs and using same techniques over long periods.	10	7.20%	7	87.50%

Advanced Data Analysis

Initial Exploratory Analysis

The survey analysis identifies BDA specific sub-skills under the 3 categories namely technical skills, conceptual skills and human skills:

The technical skills – Include knowledge of different BDA tools, data visualization, frameworks and programming languages, while python is in highest demand, and newer technologies such as machine learning and cloud computing are on the rise.

When considering the conceptual skills, the most demanded conceptual skill is creative problem solving (45% frequency) followed by analytical thinking (27%). Newer concepts such as systems thinking although accorded a lower priority, are emerging skills in recognition.

All 10 respondents placed human skills, teamwork, communication and motivation at the top and leadership skills at the lowest priority. Additionally, 3 respondents mentioned theoretical or domain knowledge as another important aspect for BDA.

The analysis also discovered several skills overlapping in categories.

Transcript Analysis

Thematic analysis on the transcribed interview transcripts is discussed below.

BDA Skills Development Initiatives

1. Main Techniques

These were identified as the most common mechanisms generic to BDA upskilling undertaken by the IT/BPM companies in Sri Lanka.

Challenges

"...One of those ways we make them think more, we conduct hackathon."

Challenging activities such as hackathons are dynamic and innovative ways of BDA upskilling for analytical, problem-solving and other conceptual and human skills while tackling technicalities for practical scenarios fostering teamwork. This is relatively a novel approach, since only one respondent (R4) mentioned it, indicating broader application potential.

Expert Sessions

"Our CEOs and operating managers come from abroad and teach us for about two weeks about what's changing and how we should manage this change."

"We do sessions from industry experts. Also, we get international lecturers who do lectures on AI... they do webinar session with us."

This theme highlights the most common mechanism (75% cases) consisting of external BDA upskilling mechanisms provided by Sri Lanka IT/BPM companies. As per R2 and R4, these refer to informative sessions from industry experts both local and international, outside workshops and seminars recommended for BDP (R3, R5, R6), enhancing both technical and non-technical expertise. The availability and use of international expertise for BDA upskilling among these outsourcing companies was significant.

Training Courses

"We run these programs, those who like to contribute in terms of data, can follow that program or we as managers can nominate people from the business. In this program we track different skillset of our analysts like SQL python and visualization."

Is a more common mechanism (62.5% cases) for improving BDA technical know-how while providing practical exposure to a certain degree. This is mostly in the form of e-learning in this era and includes online BD training courses curated by the organization for their employees to upskill non-technical people to become

technical or semi-technical people or to further advance technical employees (R4) and other recognized general courses like AWS, Microsoft, Udemy (R7, R8) recommended by the organization.

Collaborative Engagements

"This is sort of like an open auditorium. Basically, everybody can join, leave, but you can get something by listening to tech talks."

Another common approach (50% cases) of internal training mechanisms emphasize collaboration amongst teams or other relevant parties. These include cross-functional trainings, cultural groups, technology 'talks' fostering an environment of knowledge-sharing through conversations and meetups across organizational functions and amongst BDP teams, improving skills, even extending beyond core BD concepts.

"They are providing us skilled and experienced supervisors to take care of interns and give proper knowledge on analysis and handling data."

Monitoring-based BDA upskilling brings collaboration between employees and supervisors for close monitoring and supervision of the employee for BDA skills development.

Practical Engagements

"There are certain issues when you're dealing with data, quality issues and how we handle garbage data. Mostly, I think when you're working with large amounts of data, you're getting real experience and training"

Respondents R8 and R3 claim that BDA upskilling occurs mostly through actual engagement in big data tasks. Self-learning through handling big data gives the practical exposure for employees to think critically and resolve any issues that may arise during the process.

2. Supportive Techniques

These were identified as motivational factors to encourage professionals to engage in BDA upskilling among IT/BPM professionals in Sri Lanka.

Monetary Incentives

"We are providing you 100% waiver off for all the licensing and everything and we don't even ask you to do any bounding with us."

The mostly used supportive mechanism (75% cases) as all participants mention consist of incentives in the monetary form such as financial aid, monetary rewards, allowances, and waiver-offs on BDA courses like AWS and Microsoft, motivating and enabling employees to engage in BDA upskilling, while R4 highlights that such incentive programs are an essential part of upskilling.

Resources

"…To do some associated certification, we are giving you free materials, the e-learning system to practice all this stuff."

Adequate resources including technical resources such as e-learning systems, relevant tools and other learning materials were also identified as requisite for BDA upskilling.

"We are currently lacking actual paid software"

On the contrary, some IT/BPM companies in Sri Lanka still lack resources (R3) essential for BDA, mostly since BD is in its' initial stages of implementation in the country as mentioned by the respondents.

Learning Culture

Due to the rapidly evolving nature of technology, employees must continuously update their skills which demands a culture of continuous leaning within organizations.

"They provide the assistance, give us the freedom and time for self-learning and skills we need to enhance our career."

This highlights the importance of necessary support, encouragement, time and space for learning to remain competitive, especially in a fast-changing field like BD as explained by a majority (50% cases).

BDA Skills Upgrading Model

The following themes relevant for developing the BDA skills upgrade process model are discussed below.

1. Upskilling Process

Recurrent

Upskilling mechanisms being implemented in a timely manner throughout a year as pointed out by all respondents highlight BDA upskilling nature as a continuous and cyclical process.

"Hackathon, it's a bi yearly event. Webinars are monthly, probably around once in two months. These are the courses which run yearly."

37.5% cases specify that the knowledge of BDA skills gaps has brought attention on BDA upskilling from time to time within IT/BPM organizations in Sri Lanka.

Sequential

BDA upskilling takes a step-by-step approach based on respondents' responses.

"The manager will know the skillset of each individual in his team. If he thinks that there is a gap in his team, he will see what trainings need to be provided to the teammates." R6 reflects on BDA upskilling, that is after identifying skills gaps for BDA.

R2 stating "After this program, we will have some online assessment and in passing that, the employee is eligible for incentive" specify that supportive mechanisms are implemented post main BDA upskilling mechanisms completion.

Similarly, relevant responses of research participants layout the flow and steps to be followed in BDA upskilling.

2. Skills Specification

Job Description

"Whenever we do hire, we have a job description, it will specifically say the skills you need to have "

Skills specification for a particular role in BD shall make use of a 'job description' as a tool for specifying BDA skills expected by the employer.

Business requirement

"What is the company's AI and data strategy going to be? So that is where we identify the skills required "

As per R4, specific skills expected for a BDA role are determined in the initial data strategy of an organization which sets forth identifying employees possessing those specifications and subsequently upskilling for BDA.

Another viewpoint, "Business problem is identified first and then there will be a solution defined as well, in order to fill the gap between them, people are hired like that" (R6) highlights that skills are also specified based on the requirements for a particular on going or future project.

3. Skills Identification

This theme relates to determining whether a particular employee possesses the specified BDA skills.

Interviews

"You're going through a process like series of interviews, initial interview, call up interview, technical interview, then interview with the VP or the higher position, it can be sometimes CTO depends on your designation"

50% cases identify interviews as a main method of skills identification where in the modern context, most organizations conduct a series of interviews to identify attitudes, personality, skills both technical and non-technical, depending on the job role or the position the employee is being hired to.

Mini Assessments and Case Studies

"We give them IQ tests, pattern, identifying tests, writing tests, and many other things to do in order to identify whether this person can handle these big data related activities"

Case studies and small assessments such as above are also common approaches that may be a part of the interview series to identify employees' practical application abilities of BDA skills, mostly their technical competencies.

4. Skills Gap Assessment

Formal Evaluations

"Say he gets a promotion, we have assessments and based on assessment results, we analyze and identify these skill gaps. End of exam day, based on the 10 criteria defined like, visualization, processing or cleansing, we find where the employee is strong or weak"

Formal evaluation methods for BD like examinations, formal annual reviews, setting KPIs are used in IT/BPM organizations in Sri Lanka according to respondents (50% cases).

Change Monitoring

"Anytime, even a small change happens, higher up people come into our office, and thoroughly train us to prepare for these big data challenges."

Environmental change is monitored by the top management and upon understanding that these changes require improved skills, they provide BDA upskilling initiatives as an innovative way to remain competitive in the market.

Monitoring Based

R6 states "The manager will know the skill set of each and every individual in his team. If he thinks that there is a gap in his team, first, he will see how he can help the team to fill this gap."

62.5% cases indicate monitoring as an effective approach where the mentor/supervisor who maintains close relationship with the employee

makes formal or informal conversations or assessments to identify skills gap in individual employees of big data teams.

5. Industry Alignment

Industry Standards

BDA upskilling mechanisms must be aligned with continuous industrial changes. For this, R3 and R7 mention that their organizations follow the best practices of the industry and provide training courses available via globally reputed organizations like AWS or Microsoft. However, the lack of an approach to align upskilling with industrial requirements in IT/BPM companies was highlighted by R4.

Knowledge Sharing

"We are validating the big data. We do cross functional trainings to make sure that people have at least an understanding regarding operations, technical terms within data analysis."

BDA upskilling mechanisms such as technology conversations or cross-functional trainings enabling knowledge sharing of industrial best practices and trends (R1) is seen as an effective approach to ensure alignment with both organizational goals and industrial needs, while achieving an up-to-date skilled BDA workforce.

Regulations

Noted by a single respondent, R2 presents the importance for organizations to follow and adhere to regulations applicable for the organization in terms of big data for effective BDA upskilling aligning with updated BD regulations.

4.2.2.3 Other Related Findings

1. BDA Skills Gap

Human Resource

Big data is a recently adopted technology still in its uprising stage within most IT/BPM companies in Sri Lanka according to the respondents, underscoring the lack of awareness of this technology, even amongst technical professionals. It's pointed out that BD is still not utilized to its full potential in organizations.

"The gap that I see here is since people are tool oriented, specific language oriented. Unfortunately, he/she might not know how to break down, how to join his piece of work to get the solution."

R6 also highlighted the employee reliance on technical tools to get the work done instead of using their analytical abilities for it causing the BDA skills gap.

Quality

The theme identifies the lack of effective BDA upskilling mechanisms and strategies. The mental and psychological drain that is because of engaging in a highly technical aspect, other resource needs have been overlooked by companies when developing and/or implementing upskilling initiatives (R2, R5).

Moreover, currently practiced BDA upskilling methods have been in practice for years (R1), thus, updated mechanisms specific to BDA upskilling are critical to enhance BDA skills when progressing along technological advancements.

2. BD/BDA Value

Data Driven

R2, claiming their organization as data-driven explains that decision making, and daily operations are highly dependent on data, revealing the uprising of data companies in Sri Lanka, along with scope for growth.

Demand

50% of cases convey the value of investing in BD as the technology is expected to trend upwards and has seen its utilization span across borders worldwide (R1).

3. Upskilling Value

Competition

"We get skilled people; we upskill these people also in terms of data related skills so it's a win-win situation." (R2)

Upskilling for BDA produces a skilled workforce creating a competitive standing to the organization to face market competition and employees themselves become competent amongst the larger workforces.

Growth and Development

R5, "It encouraged me to do a master's in data science field and that exposure helped me to identify my skills."

R7, "We had those experts guide us towards achieving the goals and our personal development as well."

Personal growth and professional development are identified outcomes of BDA upskilling since the improved BD competence of employees creates better career prospects and individual evolvement.

Satisfaction

According to R7, "They ask our suggestions and solutions for certain challenges they face and based on our feedback, they sometimes change their decisions and how they look at certain problems. This mindset is really good because we get value for ourselves inside the company."

Allowing employees to improve their skills in technologies like BD via upskilling mechanisms like collaborative engagements that improve their professional relationships with organizational members along with BDA skills, makes them feel valued within the entity, increasing job satisfaction.

4. Further Action

Update

It was recommended by R2 that frequent reviews and analysis of skills, technology, and upskilling mechanisms is required to remain competitive in the industry although there's currently a lack in this aspect.

Requirement Alignment

"When giving targets or incentives we should think about our mental and physical capabilities."

As highlighted by Respondents (50% cases), for more productive and effective BDA upskilling to achieve the intended objectives of an organization, it's imperative to align upskilling mechanisms with employee needs.

Expansion

"If you are willing to spend more, you can give colleagues training from outside Sri Lanka, engage with other software related industry people and gain knowledge from them."

R1 suggests that the current upskilling techniques can be expanded to gain more exposure to knowledge and expertise however being considerate of financial limitations.

Findings and Discussion

Initially, the study explored specific BDA skills for IT/BPM professionals requiring development in main 3 types - technical, conceptual and human skills. As Shirani A. (2016) mentioned, BDA skills span multiple disciplines and are constantly evolving. Technical skills found frameworks like Hadoop and Apache, data visualization tools as Power BI, databases, statistical analysis and programming languages like Python, a top requirement as Davidavicienė et al. (2020) claims 'a language of choice for Machine Learning'. While technical skills are similar to that of literature (Shirani A., 2016; Stanton & Stanton, 2019), introduction of a separate skill category, 'conceptual skills' has further diversified the skills identified as "soft skills" in literature bringing in new perceptions and skills such as systems thinking to be developed for BDA. The human skills category, that is widely referred to as "soft skills" in literature (Shirani A. , 2016) identified skills such as communication, teamwork, dealing with conflict and networking as top requirements for BDA. An overlap of skills like communication with other categories highlights the difficulty on specifying BDA skills and their interrelatedness as previous studies specified (Shirani A., 2016; Dierendonck & Schmidt, 2023; Katz, 1955). Domain knowledge was also discovered an underlying crucial requirement for BDA as claimed by Shirani A. (2016).

While providing effective upskilling mechanisms is a strategy for BDA upskilling, common mechanisms undertaken by Sri Lanka IT/BPM companies found hackathons, expert sessions, coursework, collaborative knowledge sharing, monitoring-based approach and practical engagement for their BDA workforce. A majority of companies approached training courses and expert sessions while, novel approaches like challenges are yet unthought of in the industry, pausing viable opportunities for BDA upskilling.

An important observation by Ajayi and Udeh (2024) idenitified the effectiveness of online platforms such as online courses that provide a scalable, immersive learning experience, despite the adoption barriers such as high technology costs and un availability of necessary hardware and software for learners. Consequently, they suggest managing implementation to ensure inclusivity and accessibility (Ajayi & Udeh, 2024).

Focusing on collaborative approaches is also emphasized especially in the evoving IT landscape to ensure skills alignment with organizational goals (Shirani A., 2019; Ajayi & Udeh, 2024). As Ajayi and Udeh (2024) also mention, high attention on collaborative, communication and critical thinking skills in IT roles when IT projects becoming interdisciplinary. As Gishanthi et al. (2023) states, a systematic competency development program must be accomodated with appropriate remuneration, which this study highlights, employees were motivated to engage in continuous skill enhancement upon receiving monetary or non-monetary incentives, and a learning culture within their organizations. These discovered

mechanisms align with recommended BDA upskilling mechanisms for Sri Lanka (Dancs et al., 2024) and with other global best practices such as Malaysian expert trainings (Wahab et al., 2021) and Google's curated certification programs (Bhattacharya, 2023).

The industry could further benefit from incorporating advanced technologies such as Virtual Reality (VR) and Augmented Reality (AR) for real-world simulations, recommended for BDA upskilling to make learning more interactive and enjoyable (Davidavicienė et al., 2020).Moreover, to address the current global requirement to make learning adjustable to employee needs, Davidavicienė et al. (2020) points out the availability of online platforms to offer remote mentorships or personalized learning, where content and pace is tailored to the individual learner to address specific skills gap and optimize learning outcomes (Ajayi & Udeh, 2024). This could also possible to achieve through AI and ML technologies (Davidavicienė et al., 2020).

Developing BDA skills presents main benefits of BDA employees' personal and professional development, increased job satisfaction, organizations gaining highly competent workforce, becoming a competitive entity in the market, overall creating a win-win situation for both the organization and employees. However, non-consideration of employee needs such as their mental and psychological levels and technical requirements, insufficiency of advanced tools for BDA and outdated upskilling mechanisms highlighting the lack of effective mechanisms and strategies for BDA upskilling among IT/BPM professionals in Sri Lanka. Thus, making strategic upskilling and considerable investment in BDA apparent.

Following the upskilling models and mechanisms available in literature (Shirani A., 2019; Davidavicienė et al., 2020; Ajayi & Udeh, 2024), and findings from interview data, the below BDA skills upgrading process model is developed by the author to provide a systematic and strategic approach for BDA upskilling, where each step is an individual strategy leading to effective BDA upskilling.

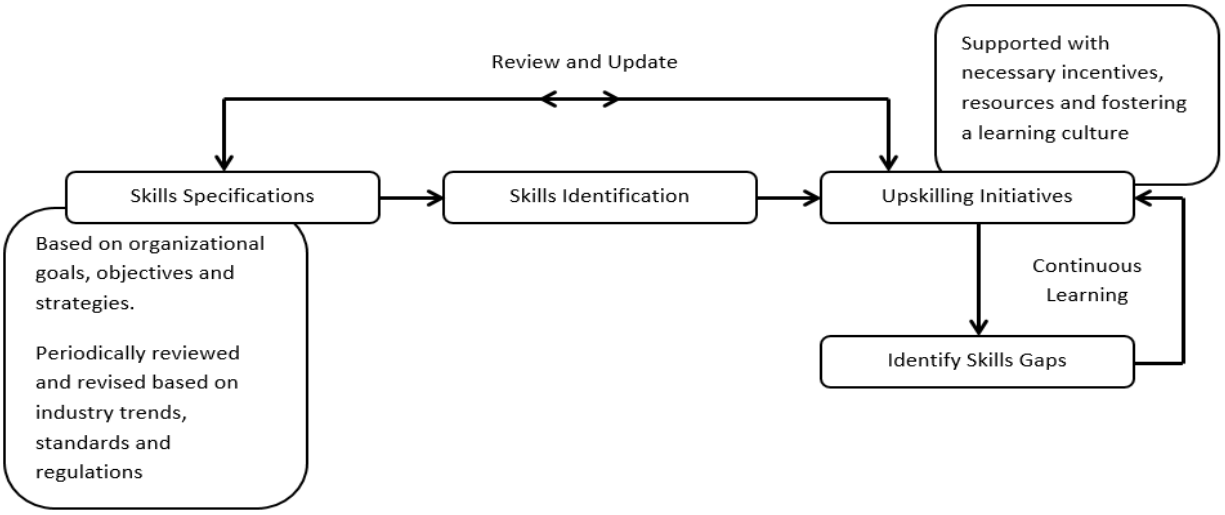


Figure *3*. Proposed BDA Skills Upgrade Process Model (Complied by Authors based on Shirani A., 2019; Ajayi & Udeh, 2024; Davidavicienė et al., 2020)

This process model consists of the steps in a sequential flow, skills specification, skills identification, upskilling initiatives/mechanisms and identifying skills gaps which provide a strategic approach to BDA skills development. Thematic analysis results of interview data provided for developing the strategic steps of the model.

Starting with skills specification, skills expected for a particular job role in BD is specified based on organizational goals, objectives and strategies and can be documented in a job description. To ensure employee suitability for BDA tasks, the skills identification stage then determines if the employee possesses the specified skills using mechanisms of interviews or a series of interviews being a common approach, or quizzes and case studies. Then, common BDA upskilling mechanisms, expert sessions, training courses, challenges, collaborative engagements and practical exposure discovered by the study are implemented as essential upskilling procedure. These mechanisms must be supported with necessary financial support, resources and an environment

fostering continuous learning to motivate employees to actively engage in BDA upskilling.

Throughout an employee's journey within a particular organization, BDA skills gaps must be identified since the explained skillset transformations for BDA (Shirani A., 2019), in ways of close monitoring or formal evaluations. This creates a repetitive process focused on continuous learning and upskilling BDA employees.

Upskilling mechanisms must also be reviewed and updated frequently to remain competitive, based on organizational strategies which are also updated based on industrial trends, best practices and the regulatory environment of the organization. Davidavicienė et al. (2020) explains big data analytics of learning behaviors, outcomes and organizations as an effective mechanism for reviewing upskilling mechanisms. These steps are not a one-time effort, instead must be carried out continuously within an organization (Shirani A., 2019).

Studies recommend a 'skills inventory' (Shirani A., 2019; Davidavicienė et al., 2020) to record and update employees' skills as an effective approach to reduce skills gaps which can be automated with the use of digital resources for example 'TrackStar' (Davidavicienė et al., 2020) and Digital Fitness app by PwC (Shirani A., 2019). Although this was not an identified approach in the local context, it is a strategy to incorporate for BDA upskilling.

While the process steps align with other identified skills upgrade models (Shirani A., 2019; Davidavicienė et al., 2020), this model is developed to reflect the current practices for BDA upskilling in IT/BPM companies in Sri Lanka and offers an extensive procedure that can be followed as a guide by other organizations and industries for upskilling for digital technologies. Moreover, implementing BDA upskilling mechanisms in a strategic approach explained by the model ensures effective skills development of the BD workforce, preparing them for BD related challenges.

Furthermore, inefficient upskilling programs being one of the critical causes, the study identified few other evident reasons for the BDA skills gap in Sri Lanka IT/BPM industry as the lack of BD skilled labor and BD awareness, and big data adoption being in its early stages. Therefore, the developed model can be used as a guide to ensure efficient and effective BDA upskilling in Sri Lanka to remain updated and compete in the BD field. Research findings also provide recommendations for employers to frequently update upskilling mechanisms, skillsets, technologies, align employee needs and expand and improve current mechanisms when upskilling for BDA. For example, incorporating personalized learning to align with employee needs as studies suggest.

The study also discusses the value of BD as a technology and BDA skills increasing in demand considering the adoption growth of this technology globally. Several literature findings also pointed out, learning big data is essential to gain high efficiencies that was not possible earlier where Li (2022) claims, inclusivity and sustainability of economies is only when people are given the opportunity to learn and fully equip with skills and competencies to work to their full potential.

Implications and Conclusions

The research study identified common upskilling mechanisms for BDA and developed a conceptual model for BDA skills upgrading of employees to achieve the main research objectives of the study. The findings were concluded from the data gathered via interviews with professionals in big data in IT/BPM companies in Sri Lanka. An initial exploration of BDA skills identified relevant skills to be upskilled under the three-type categorization of technical, conceptual and human skills as per the Katz skills framework. Moreover, the study discovered the significant value of big data and big data analytics while identifying several reasons such as lack of people in BD, insufficient awareness, overlooking employee needs, and outdated upskilling mechanisms for BDA causing a BDA skills gap in overall, while highlighting the lack of effective mechanisms and strategies for BDA upskilling a prominent issue in the Sri Lanka IT/BPM industry.

BDA skills development mechanisms included expert sessions, training courses, challenges, collaborative engagements and practical engagements supported with incentive programs and the organizational culture encouraging continuous learning. The developed process model provides a systematic and strategic approach to skills development for BDA incorporating identified mechanisms and strategies, aimed to improve upskilling for emerging technologies such as big data in Sri Lanka.

The study contributed in industrial value as it guides BDA skills development for employees in the country and in theoretical value adding to the existing literature improving knowledge and awareness regarding big data.

Upskillong BDA role require consistnat effort from multiple parties aprt from the organizations. The study implies value to policy makers of the country to facilitate BDA skills development in the nation though flexible and updated policies and procusdures. It also invite educational institutes to take initiatives towards BDA upskilling through approaches such as collaborating with the industry for co-developed curriculum.

Limitations and Future Directions

Even though big data is a trending technology today, most, including professionals in BD, lack adequate knowledge and exposure to this technology. Therefore, this field becomes an area that must be further explored.

Several limitations include the limited sample size, leading to less generalization of results, limited scope as the study primarily focuses on the mechanisms and the process for upskilling for big data and the dynamic ever-evolving nature of this technology may require updated findings. Accordingly, future directions are suggested to utilize larger sample sizes for greater generalizations and to explore areas of regulatory compliances, ethical and other challenges in BDA upskilling, how recent trends in upskilling such as customization can be practically implemented in organizations using BD, how the IT/BPM industries can further improve and optimize BDA usage and how BD can be integrated with technology advancements such as AI to optimize skills upgrading for BDP.

Competing Interests

The authors declare that they have no competing interests.

Authors' Contributions

Both authors contributed in preparing the manuscript equally. All authors have read and approved the final version of the manuscript and agree with the order of presentation of the authors.

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