

Fostering the Future Workforce in Timor-Leste: The Integration of Data Visualization, Big Data and IoT in Universities Curricula

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ABSTRACT

In today's data-driven world, the ability to effectively analyze and visualize large datasets is becoming increasingly important for students across all academic disciplines. Despite the growing importance of these skills, many universities have been slow to integrate data visualization and big data into their curricula. This article aims to explore the gap between the demand for data visualization and big data skills in the workforce and the current state of higher education in teaching these skills. Discuss the growing demand for data visualization, big data, and IoT skills in the workforce; identify the current challenges faced by universities in Timor-Leste in integrating these skills into their curricula. Highlight the importance of integrating these skills into university curricula for the future of Timor-Leste's workforce and economy, and provide suggestions for how universities can overcome the challenges of integrating these skills into the curricula. The article concludes with a call for universities to prioritize the integration of data visualization and big data in their curricula to better prepare students for the demands of the modern workforce. The methodology used to develop this article was a literature review that involved searching for relevant peer-reviewed articles, studies, reports, and other sources that have explored the topics of data visualization, big data, and IoT, and their integration into university curricula

Keywords

Data Visualization, Big data, InteloTt of Things (IIoT), Timor Leste University Curricula.

1. INTRODUCTION

Timor-Leste is the youngest nation in Southeast Asia, having experienced three periods of foreign occupation before becoming independent in 2002. It is poor, underdeveloped, and agrarian, with a GDP per capita of only \$373. Its potential economic resources include oil and gas reserves, coffee, sandalwood, marble, and tourism. Its GDP composition is made up of 55% services, 32% agriculture, and 13% industry. [1] Education in Timor-Leste has improved, but there is still a lack of connection between available education, work availability, and qualifications needed for business growth. Timor-Leste has had to rebuild its education system from scratch, and teacher preparation is a major issue. Enrolments have improved, and gender equity is close to parity, but urban-rural differences remain. [1]

Effective school leadership and teacher capacity-building are essential for improving educational outcomes in developing countries.[4]. Timor-Leste's higher education is dominated by private HEIs and centralized admission, with a focus on quality and student assessment, curriculum development, and inclusive education.[16]

Universities play a critical role in fostering the future workforce in Timor-Leste by providing students with the necessary skills and knowledge to succeed in the modern workforce. The use of data has become ubiquitous across all industries, and the need for professionals who can effectively analyze and visualize large datasets has grown accordingly. However, despite the importance of these skills, many universities have been slow to integrate data visualization and big data into their curricula. This has created a gap between the skills needed in the workforce and the skills being taught in higher education. There are 18 higher schools available in Timor-Leste, which has provided various courses including computer and informatics but there are several challenges that universities in Timor-Leste face in integrating these skills into their curricula. Some of these challenges include a lack of qualified faculty, limited resources, and a lack of industry partnerships.[8] Additionally, the relatively small size of the country may limit the availability of resources and opportunities for students to gain practical experience in many areas, including data visualization, big data, and IoT skills. Universities must prioritize the integration of data visualization, big data, and IoT into their curricula to equip students with the skills and knowledge needed to succeed in today's job market. This can be done by allocating more resources, partnering with industry leaders and experts, and encouraging interdisciplinary collaborations. The objective of this article is to bring attention to the need for universities in Timor-Leste to prioritize the development of these skills in their students to better prepare them for the demands of the job market and ensure the continued growth and development of Timor-Leste's economy. The article aims to: discuss the growing demand for data visualization, big data, and IoT skills in the workforce; identify the current challenges faced by universities in Timor-Leste in integrating these skills into their curricula. Highlight the importance of integrating these skills into university curricula for the future of Timor-Leste's workforce and economy, and provide suggestions for how universities can overcome the challenges of integrating these skills into the curricula.

2. LITERATURE REVIEW

2.1 Previous Research

There are several previous research that has examines the use of big data in IoT- driven technologies and highlight the importance of pre-processing, metadata, data storage formats, data management, and big data visualization that also explores the relationship between big data analytics and IoT, propose a new architecture, and discusses open research challenges. As described below;

Michael [6], explores the use of big data in IoT-driven technologies and highlights the importance of pre-processing, metadata, data storage formats, data management, and how big data is closely associated with IoT technologies. It also reviews the IoT reference model layers, the structure of cloud computing architecture, data acquisition, and cleaning, the importance of big data visualization, security issues, and future research directions. The Internet of Things is generating an enormous amount of data, requiring programming and statistical approaches.

Catia & Silvia [2] argue that the Internet of Things and data visualization has the potential to benefit communities by answering their needs and interests and allowing them to be active participants.

The Big Data Visualization-Assisted Multimodal Feedback Framework (BDVMFF) provides teachers and students with an effective and straightforward digital learning environment, with the highest performance ratio, efficiency ratio, grade analysis ratio, computation ratio, and lowest response time compared to existing methods.[17]

Fariza et al [5], investigate the state-of-the-art research efforts directed toward big IoT data analytics, explore the relationship between big data analytics and IoT, propose a new architecture, and discuss various opportunities brought by data analytics in the IoT paradigm, also discusses open research challenges, such as privacy, big data mining, visualization, and integration. Finally, it concludes that existing big IoT data analytics solutions remain in their early stages of development and that real-time analytics solutions that can provide quick insights will be required in the future.

These articles examine the use of big data in driven IoT drivers high lightings the importance of pre-processing, metadata, data storage formats, data management, and big data visualization. It also explores the relationship between big data analytics and IoT, proposes a new architecture, and discusses open research challenges

2.2 Definition, Benefits, and Challenges

2.2.1 Data Visualization

Data visualization is used to communicate complex data relationships and insights in an easy-to-understand way using visual elements such as charts, graphs, and maps. It can help with decision-making by providing insights that are difficult to detect in raw data. Data visualization is an important tool for businesses to analyze and share data, as it helps make the information more accessible and understandable. Data visualization is the process of converting data into a graphical representation to communicate insights and makes the information more accessible. Data visualization is used to communicate complex data relationships and insights in an easy-to-understand way. [15] Definition, Examples, and Learning Resources, i.e.) Data visualization is the graphical representation of data and information using visual elements such as charts, graphs, and maps. It is a way to effectively communicate complex data sets and patterns to a wide audience. The goal of data visualization is to present

information in a way that is easily understandable, accessible, and impactful. According to the Harvard Business Review, data visualization can help with decision-making by providing insights that would be difficult to detect in raw data. It allows individuals to identify trends, patterns, and outliers in large data sets, which can then inform business strategy or research.

Data visualization is an essential tool for businesses, organizations, and individuals to make the most of their data, providing actionable insights that can drive growth, improve decision-making, and foster innovation. The benefits of data visualization include 1. Improved Understanding: Data visualization makes it easier for people to understand complex data sets by presenting the information in clear communication: Data visualization helps communicate insights and findings effectively to stakeholders. 3. Better Decision Making: Data visualization enables people to quickly identify patterns and trends in data, which can inform better decision-making. 4. Increased Efficiency: By visualizing data, individuals can quickly identify the most important information and focus their efforts on the most relevant aspects of a problem. 5. Improved Clarity: Data visualization can help identify relationships and correlations that might otherwise go unnoticed, improving clarity and understanding.

Despite its benefits, data visualization can also present several challenges, including the need for specialized software and technical skills, the risk of oversimplifying data, and the challenge of visualizing large and complex data sets. There are several challenges associated with data visualization: 1. Data quality and complexity: Data visualization often relies on large amounts of data, which can be difficult to manage, clean, and transform into meaningful insights. Ensuring the quality of the data is critical to creating accurate visualizations. 2. Selecting the right visualization: There are many types of visualizations to choose from, and choosing the right one depends on the data set, the message being conveyed, and the audience. 3. Overloading information: Visualizations can become cluttered and difficult to understand if too much information is included. It is important to keep visualizations simple and focused on the most important information. 4. Lack of technical skills: Data visualization can require technical skills such as programming, data analysis, and graphic design. Many people may not have the necessary skills to create effective visualizations. 5. Bias in visualization: The way data is visualized can impact how it is perceived and interpreted. It is important to be mindful of how visualizations are constructed and how they might be perceived to avoid unintended bias[3][12][13][4]

2.2.2 Big Data

Big data is a term used to describe the large volume of data – both structured and unstructured – that inundates a business on a day-to-day basis. But it's not the amount of data that's important. It's what organizations do with the data that matters. Big data can be analyzed for insights that lead to better decisions and strategic business moves. Big data is a massive volume of data generated by businesses, organizations, and intern individual daily disorganizations with it that matter contains larger, more complex data sets, especially from new data sources, and can be used to address business problems.

There are several benefits of big data, including; 1. Improved decision-making: By analyzing vast amounts of data, organizations can make more informed decisions, rather than relying on intuition or past experiences.2.Increased efficiency: Big data can be used to automate processes, streamline operations and identify areas for improvement.3.Better customer understanding: By analyzing customer behavior and preferences, organizations can tailor their offerings and improve customer satisfaction.4.New product and service

development: Big data can be used to identify new opportunities for growth and innovation.5.Competitive advantage: Organizations that effectively leverage big data can gain a competitive advantage over their rivals.6.Cost savings: Big data can help organizations reduce costs by identifying inefficiencies and areas for improvement.

Big data has many benefits, such as gaining more complete answers and confidence in the data but also has its challenges, such as the acceleration and preparation of the data before it can be used. To get started, organizations should take three key actions: discover more big data resources; identify relevant data; and curate and prepare data. Storage solutions can be in the cloud, on-premises, or both. [21]. Big data presents several challenges that need to be overcome to fully utilize its potential benefits. These challenges include; 1. Data Volume: The sheer volume of big data makes it difficult to store and process, leading to a need for high-performance computing systems.2.Data Variety: Big data comes in many different forms, such as structured, semi-structured, and unstructured data. This variety makes it challenging to manage and integrate data from different sources. 3. Data Velocity: The speed at which big data is generated, collected, and processed presents a significant challenge to businesses. They need to be able to process the data in real time to get value from it. 4. Data Veracity: The quality and accuracy of big data can be questionable, and it can be difficult to verify the authenticity of the data.5.Data Security and Privacy: Big data often contain sensitive information that must be protected to ensure privacy and security. 6. Data Analytics: Turning big data into valuable insights requires advanced analytics techniques, which can be complex and time-consuming to implement.7.Lack of Talent: There is a shortage of professionals with the skills necessary to analyze and interpret big data. These challenges need to be addressed to fully leverage the benefits of big data and overcome any limitations it may present.

2.2.3 Internet Of Things (IoT)

The Internet of Things (IoT) is a system of interconnected physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, and connectivity which enables these objects to collect and exchange data. It is a network of physical objects that contain embedded technology to communicate and sense or interact with their internal states or external environment. IoT is transforming the way we live and work by creating smart, connected environments that can be monitored, managed, and controlled remotely. The increasing interconnectivity of devices through the IoT is creating vast amounts of data that can be used to drive insights and inform decision-making in a variety of industries and applications. The Internet of Things (IoT) is a universal system of interrelated networks of computers that use Internet Protocols (IPs) and Transmission Control Protocols (TCPs) to serve billions of users around the world. It is a universal network that allows communication between humans, things, and humans through a unique identity. [11]

The Internet of Things (IoT) is a system of physical devices, vehicles, home appliances, and other items that are embedded with electronics, software, sensors, and connectivity which enables these objects to connect and exchange data over the Internet. The benefits of IoT are many and varied, including: 1. Increased Efficiency: IoT devices can automate many tasks and provide real-time data that can be used to optimize processes and improve efficiency.2.Improved Customer Experience: IoT devices can collect and analyze data to provide better customer experience, such as in retail stores using sensors to track customer behavior and provide personalized recommendations.3.Better Decision Making: IoT devices can

provide real-time data that can be used to make informed decisions in a variety of industries, such as in healthcare where patient data can be monitored and analyzed to improve patient outcomes.4. Predictive Maintenance: IoT devices can monitor equipment and systems, alerting maintenance teams to potential issues before they become bigger problems.5.Cost Savings: By automating processes and reducing the need for manual labor, IoT can help to lower operating costs for businesses and industries.6.Increased Safety: IoT devices can be used to improve safety in a variety of settings, such as in factories where sensors can detect dangerous conditions and alert workers. Overall, the benefits of IoT can be seen in increased efficiency, improved customer experiences, better decision-making, predictive maintenance, cost savings, and increased safety. . The Internet of Things (IoT) has the potential to empower people, reduce accidents, and create productivity gains. [10]

The Internet of Things (IoT) refers to the interconnectivity of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, and connectivity which enables these objects to connect and exchange data. However, there are also several challenges to the implementation of IoT, including 1. Security concerns: As IoT systems collect and transmit vast amounts of data, they are vulnerable to hacking and cyber-attacks.2.Interoperability issues: Different IoT devices may not be compatible with each other, making it difficult to integrate them into a single system.3.Data privacy: The collection and storage of personal data by IoT devices raise concerns about data privacy and the protection of personal information.4.Technical complexity: IoT systems can be complex and difficult to set up and maintain, requiring specialized skills and knowledge.5.Regulation: There is a lack of clear regulations and standards for IoT, making it difficult for organizations to know how to comply with legal requirements.

3. METHODOLOGY

The methodology used to develop this article is a literature review is a research method that involves collecting, analyzing, and summarizing existing research on a particular topic involved searching for relevant peer-reviewed articles, studies, reports, and other sources that have explored the topics of data visualization, big data, and IoT, and their integration into university curricula, involved identifying key keywords, phrases, and themes related to these topics and conducting a comprehensive search of academic databases and online sources to gather information.

The method of literature review develops a comprehensive understanding of the current state of knowledge on data visualization, big data, and IoT and the integration into university curricula, and uses this information to develop the article's main findings and recommendations.

4. RESULT AND DISCUSSIONS

4.1 Integration of Data Visualization, Big Data, and IoT into Curricula

Integrating data visualization, big data, and IoT into university curricula is becoming increasingly important as the demand for these skills continues to grow in the workforce. The integration of these skills helps to prepare students for the demands of the modern workforce and the changing needs of the economy. Data visualization is the process of representing data and information in a graphical or pictorial form, making it easier to understand and interpret. The benefits of data visualization include improved decision-making, increased understanding of

complex data, and the ability to communicate insights more effectively.

Big data refers to the large and complex sets of data that traditional data processing techniques are unable to handle. The benefits of big data include the ability to make more informed decisions, improve operational efficiency, and gain a competitive advantage. However, some challenges of big data include data privacy and security, data quality, and data storage and processing.

IoT refers to the interconnected network of devices, sensors, and systems that collect and exchange data over the Internet. The benefits of IoT include increased automation and efficiency, improved decision-making, and the ability to monitor and control devices remotely. However, some challenges of IoT include data privacy and security, data quality, and the integration of multiple devices and systems.

Universities that prioritize the integration of these skills into their curricula are better equipped to prepare their students for the demands of the modern workforce. This requires a concerted effort by universities to address the challenges they face, such as a lack of resources and expertise, and to implement effective teaching methods to equip students with the necessary skills and knowledge.

Integrating data visualization, big data, and IoT into university curricula is crucial for fostering the future workforce and preparing students for the changing needs of the economy. By addressing the challenges and implementing effective teaching methods, universities can play a very important role in equipping their students with the knowledge and skill they need to succeed in the modern workforce.

4.2. Benefit of integrating Data Visualization, Big Data, and IoT into university

There are several benefits of integrating Data Visualization, Big Data, and IoT into university education. Some of these benefits include:[9]

1. **Better preparation for the workforce:** By integrating these skills into the university curriculum, students will be better prepared to enter the workforce with the skills that are in demand. This will help bridge the gap between the skills that students learn in the classroom and the skills that are required in the job market.
2. **Improved decision-making:** Data visualization and big data skills enable individuals to make more informed decisions by visualizing large and complex data sets. This skill is becoming increasingly important as organizations and governments rely more heavily on data to drive their decisions.
3. **Improved economic outcomes:** By developing a workforce with the skills to effectively utilize data visualization and big data, countries such as Timor-Leste can improve their economic outcomes. This can be achieved by using data to drive economic growth, increase efficiency, and make informed decisions.
4. **Improved efficiency:** The Internet of Things (IoT) allows for the creation of connected systems that can improve efficiency and reduce costs. By integrating IoT into university curricula, students can develop the skills to design, build, and maintain these systems.
5. **A better understanding of technology:** Integrating these skills into the university curriculum will help students develop a better understanding of technology and its role in society. This will equip them with the knowledge and skills to drive innovation and bring new ideas to the market.

On the other hand Data visualization, big data, and IoT are all important components for building a smart university. Big data refers to the massive amounts of data that are generated by various sources, including sensors, social media, and other digital devices. IoT devices are used to gather this data, which is then analyzed using big data analytics tools to uncover patterns and insights. Data visualization is the process of presenting this data in a graphical or pictorial format that is easy to understand. Data visualization tools are used to create visual representations of the data, such as charts, graphs, and diagrams. In the context of building a smart university, IoT devices can be used to gather data from various sources, such as classrooms, libraries, and student housing. This data can then be analyzed using big data analytics tools to gain insights into various aspects of the university, such as student behavior, energy usage, and facility management. Data visualization tools can be used to create interactive dashboards and reports that provide a visual representation of this data. These visualizations can be used by university administrators and faculty to make informed decisions about resource allocation, academic programs, and facilities management. The relationship between data visualization, big data, and IoT is crucial for building a smart university. By gathering and analyzing data from various sources and presenting it in a visual format, university administrators and faculty can gain insights that enable them to make informed decisions about the university's operations and resources.

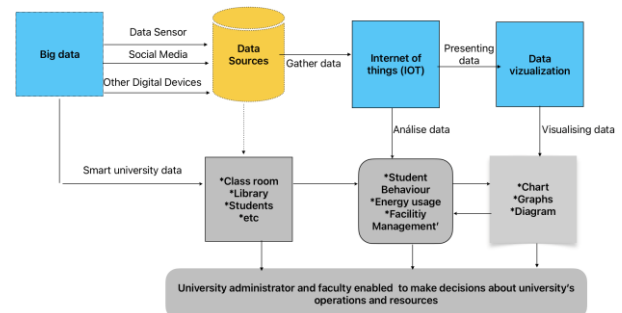


Figure 1: Relationship of tween data visualization, big data and IOT for Building smart-university

4.3. Courses /subjects offer for Data visualization, big data, and IoT at the university

The universities that are implementing these subjects into their curricula may vary based on region and available resources. Additionally, the subjects and applications used to teach these skills may also vary depending on the specific needs and goals of each university.

Some of the universities that are well-known for their expertise in these areas include MIT, Stanford, UC Berkeley, Carnegie Mellon, and the University of Illinois at Urbana-Champaign. These universities offer a range of subjects including data visualization, data science, big data analytics, and IoT, among others, and use a combination of traditional lectures, hands-on projects, and industry collaborations to impart these skills. For Universities to need the null to the growing demand for data visualization, big data, and IoT skills in the workforce. These subjects can include data analysis, business intelligence, machine learning, statistics, and programming languages such as Python, R, and SQL.

1. **Data visualization courses** typically focus on teaching students how to effectively communicate information through visual representations, using tools such as graphs, charts, and maps. These courses also cover design

principles, data visualization best practices, and the use of various software applications such as Tableau and PowerBI.

2. Big data courses, on the other hand, aim to introduce students to the concepts of big data and how it can be harnessed to drive business decisions. These courses cover topics such as data storage, data processing, and data analysis using Hadoop, Spark, and NoSQL databases.
3. IoT courses introduce students to the world of connected devices and the data they generate. These courses cover topics such as IoT architecture, IoT security, IoT device management, and IoT data analysis. Students will also learn how to develop IoT applications using platforms such as AWS IoT and Microsoft Azure IoT.

The integration of data visualization, big data, and IoT into university curricula will not only equip students with the skills they need to succeed in the modern workforce but will also contribute to the development of a thriving digital economy in Timor-Leste.

4.4. The current challenges faced by universities in Timor-Leste in integrating these skills into their curricula

The current challenges faced by universities in Timor-Leste in integrating data visualization, big data, and IoT into their curricula are likely to be similar to those faced by universities around the world. Some of these challenges include:

1. Lack of resources: Universities may not have the financial or technical resources to implement new programs and courses in these areas.
2. Lack of expertise: Universities may not have the expertise to teach these complex topics, especially in the field of big data and IoT.
3. Curriculum development: Developing new courses and programs in these areas requires careful planning and design, which may be time-consuming and challenging for universities.
4. Resistance to change: There may be resistance from traditional academics or university administrators who are reluctant to change the existing color curricula with technology: Data visualization, big data, and IoT are rapidly evolving fields, and universities may struggle to keep up with the latest developments and advancements.
5. These challenges must be addressed in universities in Timor-Leste to integrate these skills into their curricula and prepare their students for the demands of the modern workforce.

4.5. The importance of integrating data visualization, big data, and IoT skills into university curricula

Integrating data visualization, big data, and IoT into university curricula is crucial for the future of Timor-Leste's workforce and economy. These skills are becoming increasingly important in the modern workforce, and universities must respond to these changing needs to prepare students for success in their factors.[7]

Data visualization skills are in high demand as they allow individuals to effectively communicate complex information in a way that is easy to understand and interpret. Big data skills are also in high demand, as they allow individuals to analyze large amounts of data and make informed decisions based on the insights they uncover. IoT skills are becoming increasingly important as well, as they allow individuals to design, implement, and manage the connected devices and systems that make up the Internet of Things.

By integrating these skills into their curricula, universities can ensure that their students are well-prepared to meet the demands of the modern workforce. This can lead to increased job opportunities for graduates, and can also drive economic growth and development in Timor-Leste by creating a more highly-skilled and competitive workforce.

4.6. Suggestion to the university to overcome the challenges of integrating

To overcome the challenges of integrating data vTon, big data, and IoT into university curricula in Timor-Leste, several universities can take. Here are some suggestion elaboration Universities can collaborate with industry partners, government agencies, and other organizations that are already utilizing these skills in order into what is needed in the workforce.

1. Curriculum Development: Universities can work on developing new and updated curricula that incorporate data visualization, big data, and IoT. This can be done through partnerships with industry experts, workshops and training programs, and the integration of case studies and real-world projects into coursework.
2. Skill development: Universities can provide opportunities for students to develop practical skills in data visualization, big data, and IoT through internships, co-op programs, and other hands-on learning opportunities.
3. Faculty training: Universities can provide training and resources for faculty members in top them effectively integrate these skills into their practices. This can include workshops, online resources, and the provision of hardware and software needed to teach these skills.
4. Public-private partnerships: Universities can partner with private-sector companies and organizations that are already utilizing these skills to provide students with real-world experience and to apply what they have learned in the classroom.
5. Continuous improvement: Finally, universities can continuously evaluate and refine their curricula, teaching methods, and student outcomes to ensure that they are effectively integrating students the into force.

By taking these steps, universities can overcome the challenges of integrating data visualization, big data, and IoT into their curricula, and help to foster the future workforce in Timor-Leste.

5. CONCLUSION

Data visualization, big data, and IoT are becoming increasingly important skills in the modern workforce. With the growing demand for these skills, universities need to integrate them into their universities' future to be a smart university. Universities must take steps to impostor skills into their curricula. However, there are several challenges that universities in Timor-Leste face in doing so. Some of these challenges include a lack of resources and expertise, limited funding for technology and training, and a shortage of qualified faculty to teach these skills. Despite these challenges, it is essential for universities in Timor-Leste to prioritize the integration of data visualization, big data, and IoT into their curricula to prepare students for the demands of the made working so, they will be able to equip their students with the necessary skills to succeed in a rapidly changing job market and contribute to the overall growth and development of Timor-Leste's economy.

To overcome these challenges, universities in Timor-Leste can take several steps. One of these is to collaborate with industry experts and organizations to obtain funding, resources, and support for technology and training. Another is to create partnerships with other universities and organizations to share expertise and resources and to offer joint programs and

workshops. Additionally, universities can work with government agencies to develop policies that support the integration of these skills into their curricula.

In conclusion, universities in Timor-Leste must integrate data universities main integrate to foster the future workforce and support the growth and development of the country's economy. By addressing the challenges and taking proactive steps, universities can ensure that their students are well-equipped to succeed in a rapidly changing job market and contribute to the future prosperity of Timor-Leste.

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