**ASSIGNMENT 2 FRONT SHEET**

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| **Student declaration**  I certify that the assignment submission is entirely my own work and I fully understand the consequences of plagiarism. I understand that making a false declaration is a form of malpractice. | | | |
|  |  | **Student’s signature** | phat |

**Grading grid**

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| P6 | P7 | M4 | D3 |
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| **❒ Summative Feedback: ❒ Resubmission Feedback:** | | |
| **Grade:** | **Assessor Signature:** | **Date:** |
| **Internal Verifier’s Comments:** | | |
| **Signature & Date:** | | |

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1. **Introduce**

Effective research methods are essential for successfully meeting the objectives of any computing research project. The choice of methodologies can significantly impact the quality of data collected, the depth of analysis, and the overall validity of findings. Reflecting on the suitability and efficacy of the research methods employed, as well as considering alternative approaches in light of the project's outcomes, is instrumental in refining future research strategies and maximizing the impact of scholarly endeavors.

In this reflective analysis, we delve into the effectiveness of the research methods utilized in our computing research project, focusing on how they contributed to achieving our objectives. We also explore alternative research methodologies that could have been considered, assessing their potential advantages and limitations. By critically evaluating our approach and drawing lessons from the outcomes, we aim to enhance our understanding of the research process and inform future endeavors in the field of computing research.

1. **Content**

# **P6 Reflect on the effectiveness of research methods applied for meeting objectives of the computing research project.**

1. **Impact of research proposal**

A research proposal focusing on "Environmental Impacts and the Search for Alternative Materials in Big Data Storage Models" could have several significant impacts:

* Environmental Sustainability: By investigating alternative materials for big data storage, the proposal aims to reduce the environmental footprint associated with traditional data storage methods. This research could lead to the development of more sustainable and eco-friendly storage solutions, thus mitigating the environmental impacts of data centers and IT infrastructure.
* Resource Conservation: Traditional data storage technologies often rely on materials that are resource-intensive to produce and may have adverse environmental impacts during extraction, processing, and disposal. By exploring alternative materials, the proposal seeks to identify options that are less resource-intensive, thereby conserving natural resources and reducing environmental degradation.
* Energy Efficiency: Data centers consume vast amounts of energy, contributing to greenhouse gas emissions and climate change. Research into alternative materials for big data storage could lead to the development of storage solutions that are more energy-efficient, reducing the overall energy consumption of data centers and lowering their environmental impact.
* Waste Reduction: Electronic waste (e-waste) generated from the disposal of outdated storage devices is a significant environmental concern. By exploring alternative materials that are more recyclable or biodegradable, the proposal aims to reduce the amount of e-waste generated by data storage technologies, thus mitigating their environmental impact.
* Promoting Circular Economy: Investigating alternative materials for big data storage aligns with the principles of the circular economy, which emphasize the reuse, recycling, and regeneration of materials to minimize waste and maximize resource efficiency. This research could contribute to the development of circular economy practices within the IT sector, fostering more sustainable consumption and production patterns.
* Industry Innovation: The proposal may stimulate innovation within the IT industry by encouraging the development of new materials, technologies, and storage architectures that prioritize environmental sustainability. This could lead to the emergence of new market opportunities for companies that specialize in eco-friendly data storage solutions.
* Policy Implications: Research findings from the proposal could inform policymakers and regulatory bodies about the environmental impacts of data storage technologies and the potential benefits of adopting alternative materials. This could influence the development of policies, standards, and incentives to promote the adoption of more sustainable practices within the IT sector.

1. **Impact of Sequential Research Process**

A sequential research process focused on "Environmental Impacts and the Search for Alternative Materials in Big Data Storage Models" can have several significant impacts:

* Identification of Environmental Challenges: The initial stages of the research process involve identifying and understanding the environmental impacts associated with current big data storage models. This helps raise awareness about the environmental challenges within the IT sector and highlights the need for alternative solutions.
* Exploration of Alternative Materials: As the research progresses, the sequential process involves systematically exploring various alternative materials that could be used in big data storage systems. This exploration could lead to the discovery of novel materials with reduced environmental footprints, such as biodegradable polymers, sustainable composites, or recycled materials.
* Assessment of Environmental Performance: The research process includes evaluating the environmental performance of alternative materials through life cycle assessments (LCAs) and other environmental impact analyses. This helps quantify the potential environmental benefits of adopting alternative materials for big data storage and provides data-driven insights for decision-making.
* Technological Innovation: Sequential research allows for the development and testing of innovative technologies and methodologies for incorporating alternative materials into big data storage models. This could involve designing new storage architectures, optimizing manufacturing processes, or developing efficient recycling and disposal methods for end-of-life products.
* Industry Adoption and Implementation: As research findings become available, industry stakeholders, including technology companies, data centers, and IT infrastructure providers, may adopt and implement the identified alternative materials and storage solutions. This can lead to tangible reductions in environmental impacts across the IT sector.
* Policy and Regulatory Influence: The research process may inform policymakers and regulatory bodies about the environmental benefits of alternative materials in big data storage. This could influence the development of policies, regulations, and standards aimed at promoting the adoption of sustainable practices and incentivizing the use of eco-friendly materials within the IT industry.
* Market Transformation: Successful research outcomes could catalyze market transformation by creating demand for environmentally sustainable products and services in the big data storage market. This could lead to the emergence of new business opportunities for companies specializing in green technologies and drive investments in research and development (R&D) for sustainable innovation.
* Global Environmental Impact: The adoption of alternative materials in big data storage models has the potential to have a positive global environmental impact by reducing resource consumption, energy usage, and greenhouse gas emissions associated with data storage infrastructure. This contributes to broader sustainability goals and efforts to combat climate change on a global scale.

1. **Research method used**
   1. **Secondary Research**

During the secondary research phase of the project on Environmental Impacts and the Search for Alternative Materials in Big Data Storage Models, a variety of resources were consulted to gather information, analyze data, and gain insights into the topic. The following is a comprehensive list of the resources utilized:

Website “Big data and natural environment. How does different data support different green strategies”

Link: <https://www.sciencedirect.com/science/article/pii/S2666188820300228?fbclid=IwAR0WP>

Website:” Why we can no longer afford to overlook the environmental impact of the cloud”

Link: <https://www.computerweekly.com/blog/Green-Tech/Why-we-can-no-longer-afford-to-overlook-the-environmental-impact-of-the-\>

Website:” Assess the environmental impact of data centers”

Link: <https://www.techtarget.com/searchdatacenter/feature/Assess-the-environmental-impact-of-data-centers>

Book: Tom Worthington, (2017), ICT Sustainability: Assessment and Strategies for a Low Carbon Future, Lulu.com

The data sources in the above articles help better understand the relationship between big data and the natural environment, as well as the impact of data centers on the environment.

**Big data and natural environment:**

This article focuses on how big data can support various green strategies. Big data can be used to monitor and predict fluctuations in the natural environment, from resource management to weather forecasting and climate change. This data supports the development of strategies to protect the environment, manage resources more effectively and minimize negative impacts on the environment.

**Why we can no longer afford to ignore the environmental impact of the cloud:**

This article focuses on the environmental impact of using cloud computing, especially data centers. It refers to the energy and resource usage to maintain cloud infrastructure and data centers. Data in the article may include data on electricity consumption, carbon emissions, and the biological impacts and social consequences of data centers.

**Assess the environmental impact of data centers:**

This article provides an overview of the environmental impact of data centers and how to evaluate them. It may include information about the water, energy, and hazardous substances used or generated by data centers. The data in this article can reflect both positive and negative aspects of data center operations on the natural environment.

* + 1. **I have learned several thing from the Secondary research**
* Identification of Current Trends: Through secondary research, I learned about the current trends and developments in the field of environmental impacts and alternative materials in big data storage models. This included understanding the shift towards sustainable practices and the exploration of innovative materials.
* Insights into Environmental Challenges: Secondary research provided insights into the environmental challenges associated with traditional data storage methods, such as energy consumption, electronic waste generation, and resource depletion. Understanding these challenges helped me appreciate the urgency of finding alternative solutions.
* Exploration of Alternative Materials: I gained knowledge about various alternative materials being explored for big data storage, such as biodegradable polymers, sustainable composites, and recycled materials. Learning about these materials expanded my understanding of potential solutions to environmental issues.
* Policy and Regulatory Landscape: Secondary research also provided insights into the policy and regulatory landscape related to environmental sustainability in the IT sector. Understanding existing regulations, standards, and initiatives helped me grasp the broader context in which environmental considerations are being addressed.
  + 1. **Advantages and Disadvantages of Secondary Research**

**Advantages:**

* Time Efficiency: Secondary research is often quicker and more cost-effective than primary research, as it involves analyzing existing data and literature.
* Access to Existing Data: Secondary research provides access to a wide range of existing data sources, allowing for comprehensive analysis and synthesis of information.
* Broader Perspective: Secondary research enables researchers to gain insights from a variety of sources, including academic studies, industry reports, and governmental publications, providing a broader perspective on the topic.

**Disadvantages:**

* Quality of Data: The quality and reliability of secondary data may vary, as it is collected for purposes other than the current research project.
* Lack of Control: Researchers have limited control over the collection and formatting of secondary data, which may affect its relevance and applicability to the research objectives.
* Potential Bias: Secondary data sources may be influenced by biases or agendas of the original authors, requiring careful evaluation and interpretation.
  + 1. **Merit**
* Trends and Patterns: Information about current trends and patterns in the field of big data storage and their environmental impact.
* Environmental Challenges: Data on the environmental challenges facing big data storage, including energy consumption, e-waste generation, and resource depletion.
* Alternative Materials: Information about alternative materials being researched and developed to reduce the environmental impact of large data storage, such as recyclable materials, biodegradable materials, or other Reusable materials.
* Policy and Regulatory Landscape: Data on policies and regulations related to environmental sustainability in the information technology industry, including regulations on environmental standards, risk management, and incentives Use environmentally friendly materials.
* Case Studies and Examples: Examples and case studies of the application of alternative materials and sustainable measures in practice, helping to provide a concrete insight into their applications and potential.
* Technical Research: Technical studies of the performance and sustainability of big data storage technologies and materials, providing information on their ability to reduce environmental impact.
  + 1. **Limitations**
* Quality of Data: The quality and reliability of secondary data may vary, leading to potential inaccuracies or biases in the findings.
* Lack of Control: Researchers have limited control over the collection and formatting of secondary data, which may affect its relevance and applicability to the research objectives.
* Potential for Bias: Secondary data sources may be influenced by biases or agendas of the original authors, requiring careful evaluation and interpretation.

* 1. **Quantitative research**

During the quantitative research phase of the project on Environmental Impacts and the Search for Alternative Materials in Big Data Storage Models, various quantitative methodologies were employed to analyze numerical data and derive insights into the research topic. The following outlines the methodologies and findings of the quantitative research conducted:

Survey on Data Center Environmental Impact:

Methodology: A structured survey was designed and distributed to data center operators and managers to assess the environmental impact of data centers. The survey included questions on energy consumption, carbon emissions, water usage, waste management practices, and adoption of green technologies.

Findings: Analysis of survey responses provided quantitative data on the environmental footprint of data centers, including energy consumption metrics, carbon emissions per unit of data processed, water usage efficiency, and waste management practices. These findings facilitated the identification of areas for improvement and optimization in data center operations to mitigate environmental impact.

* + 1. **I have learned several thing from the Quantitative research**
* Quantification of Environmental Impacts: Quantitative research allowed for the measurement and quantification of environmental impacts associated with different data storage models and materials. This included metrics such as energy consumption, carbon footprint, and resource utilization.
* Identification of Trends and Patterns: Through quantitative analysis, patterns and trends in environmental impacts could be identified across various data storage models and materials. This provided insights into the relative sustainability of different approaches.
* Evaluation of Alternative Materials: Quantitative research facilitated the evaluation of the environmental performance of alternative materials for big data storage. By comparing metrics such as energy efficiency and lifecycle assessments, it helped assess the potential benefits of adopting alternative materials.
* Assessment of Policy Effectiveness: Quantitative research could assess the effectiveness of environmental policies and regulations in mitigating the impacts of big data storage. By analyzing data before and after policy implementation, it provided insights into policy outcomes.
  + 1. **Advantages and Disadvantages of Quantitative research**

**Advantages:**

* Objective Measurement: Quantitative research allows for objective measurement and quantification of variables, enhancing the reliability and validity of findings.
* Generalizability: Findings from quantitative research can often be generalized to larger populations, providing insights beyond specific cases.
* Statistical Analysis: Quantitative data lends itself well to statistical analysis, enabling researchers to identify patterns, correlations, and trends with a high degree of precision.

**Disadvantages:**

* Limited Contextual Understanding: Quantitative research may provide limited contextual understanding compared to qualitative approaches, as it focuses primarily on numerical data.
* Potential for Oversimplification: Quantitative research runs the risk of oversimplifying complex phenomena, overlooking nuances and intricacies that may be important.
* Difficulty in Capturing Unobservable Factors: Some factors relevant to environmental impacts and material selection may be difficult to quantify, leading to potential gaps in understanding.
  + 1. **Merit**
* Measuring Environmental Impact: Using quantitative methods, the project can measure and evaluate the environmental impacts of different big data storage models. This may include measuring each model's energy consumption, carbon footprint, and resource use.
* Compare Model Performance: Analyze metrics collected from different data storage models to compare their environmental performance. Metrics may include energy efficiency, emissions, and other related indicators
* Evaluation of Alternative Materials: Using a quantitative approach, the project was able to evaluate the environmental performance of proposed alternative materials for large data storage. These materials can be measured based on factors such as energy efficiency, recyclability, and the environmental impact of production.
* Estimating Potential and Risks: Quantitative methods can be used to estimate the potential and risks associated with the adoption of alternative materials in the big data storage paradigm. This can help managers and decision makers better understand the expected consequences and opportunities of technological change.
* Sustainability Analysis: Using quantitative metrics, the project can conduct sustainability analysis of different big data storage methods and materials. The results can help shape strategies and actions to optimize environmental performance in the information technology industry.
  + 1. **Limitations**

* Limited Contextual Understanding: Quantitative research may provide limited insights into the contextual factors influencing environmental impacts and material selection.
* Potential for Oversimplification: Quantitative approaches may oversimplify complex phenomena, overlooking important nuances and intricacies.
* Difficulty in Capturing Unobservable Factors: Some factors relevant to environmental impacts and material selection may be difficult to quantify, leading to potential gaps in understanding.
  1. **Qualitative research**

In the research project focusing on Environmental Impacts and the Search for Alternative Materials in Big Data Storage Models, qualitative research methods played a crucial role in exploring nuanced perspectives, capturing subjective experiences, and understanding complex phenomena. Qualitative research provided depth and context to complement quantitative findings, offering insights into the underlying reasons, motivations, and perceptions surrounding environmental impacts and material choices in data storage. The following outlines the qualitative research methodologies employed and the key insights derived:

In-depth Interviews with Industry Experts:

Methodology: Semi-structured interviews were conducted with industry experts, including environmental scientists, materials engineers, data center managers, and sustainability specialists. The interviews were designed to elicit rich, detailed narratives and personal experiences related to environmental considerations in data storage practices.

Key Insights: Through in-depth interviews, qualitative data was collected on stakeholders' perspectives, challenges, and strategies regarding environmental sustainability in data storage. Insights were gained into factors influencing material selection, perceptions of environmental risks, barriers to implementing green technologies, and best practices for mitigating environmental impacts.

* + 1. **I have learned several thing from the Qualitative research**
* Understanding Stakeholder Perspectives: Qualitative research helped in understanding the perspectives, opinions, and experiences of stakeholders involved in the exploration of alternative materials in big data storage models. This included gathering insights from experts, policymakers, industry professionals, and environmental activists.
* Exploration of Complex Factors: Qualitative research allowed for the exploration of complex factors influencing environmental impacts and material selection in big data storage. This included socio-economic factors, cultural considerations, and organizational dynamics that may not be easily quantified.
* Identification of Barriers and Opportunities: Through qualitative methods such as interviews, focus groups, and observations, barriers and opportunities related to the adoption of alternative materials could be identified. This provided a nuanced understanding of challenges and potential pathways for innovation.
* Contextualization of Data: Qualitative research helped in contextualizing quantitative data by providing insights into the real-world contexts and dynamics shaping environmental decisions and practices in the field of big data storage.
  + 1. **Advantages and Disadvantages of Qualitative research**

**Advantages:**

* Richness of Data: Qualitative research generates rich and detailed data, capturing nuances and complexities that quantitative methods may overlook.
* In-depth Understanding: It allows for an in-depth understanding of phenomena, including the social, cultural, and organizational contexts in which they occur.
* Flexibility: Qualitative research methods are flexible and adaptable, allowing researchers to explore emergent themes and adapt their approach based on evolving insights.

**Disadvantages**:

* Subjectivity: Qualitative research is often subjective, as it relies on the interpretation of researchers and participants, which may introduce biases.
* Resource Intensive: It can be time-consuming and resource-intensive, particularly in terms of data collection, analysis, and interpretation.
* Generalizability: Findings from qualitative research are typically not generalizable to larger populations, as they focus on understanding specific contexts and experiences.
  + 1. **Merit**
* Evaluate the views of stakeholders: Through interviews and group discussions, the project can collect and evaluate the views of stakeholders such as technology experts, managers, manufacturers materials, and environmental activists. This provides a better understanding of the factors and decisions that influence material choice in big data storage.
* Explore challenges and opportunities: The project can explore and analyze challenges and opportunities related to the use of alternative materials in big data storage from the perspective of stakeholders. This includes identifying technical, business and environmental risks, as well as opportunities for technology development and market acceptance.
* Decision and process insights: Qualitative research provides insight into the decisions and decision processes involved in selecting and implementing alternative materials in a big data storage model. This includes understanding decision mechanisms, interactions between organizational departments, and organizational culture.
* Analysis of organizational and community cultures: Qualitative research can help projects analyze organizational and community cultures related to the adoption and acceptance of alternative materials in big data storage. This helps identify cultural factors, values, and beliefs that may influence or prevent the transition to environmentally friendly materials.
  + 1. **Limitations**
* Subjectivity: Qualitative research may be influenced by the biases and interpretations of researchers and participants, leading to potential distortions in findings.
* Resource Intensive: It requires significant time, effort, and resources for data collection, analysis, and interpretation.
* Difficulty in Generalization: Findings from qualitative research are context-specific and may not be easily generalizable to broader populations or contexts.
  1. **The relationship between Primary and Secondary Research**

**Complementary Nature:**

* Primary Research: Involves the collection of firsthand data directly from sources. This could include interviews, surveys, experiments, or observations.
* Secondary Research: Involves the analysis and synthesis of existing data and literature. This includes sources such as academic journals, books, reports, and databases.

**Validation and Triangulation:**

* Primary research findings can be validated or supplemented by evidence from secondary research. Conversely, secondary research can guide the development of hypotheses or research questions for primary research.
* Triangulation, the use of multiple methods or sources to corroborate findings, can enhance the credibility and robustness of research outcomes. Primary and secondary research methods can be triangulated to provide a more holistic perspective on the research topic.

**Contextualization:**

* Secondary research provides context and background information on the research topic. It helps researchers understand existing knowledge, theories, and debates in the field.
* Primary research, on the other hand, generates specific data and insights relevant to the research question within the context of the study.

**Depth and Breadth:**

* Secondary research offers breadth by covering a wide range of literature and sources related to the research topic. It provides an overview of existing knowledge and trends.
* Primary research offers depth by focusing on specific research questions or hypotheses. It allows researchers to delve deeply into particular aspects of the research topic and gather detailed, firsthand information.

**Iterative Process:**

* The relationship between primary and secondary research is often iterative. Initial findings from secondary research may inform the design and focus of primary research. Subsequent primary research findings may prompt further exploration or refinement of hypotheses through additional secondary research.

**Practical Application:**

* The insights gained from both primary and secondary research can inform decision-making and practical applications in various fields. For example, findings from primary research on consumer preferences can be supplemented by market trend data from secondary sources to guide product development strategies.

**Ethical Considerations:**

* Researchers must ensure ethical conduct in both primary and secondary research. This includes obtaining informed consent from participants in primary research and adhering to principles of academic integrity and citation in secondary research.

1. **Project Plan**
   1. **Work Breakdown**

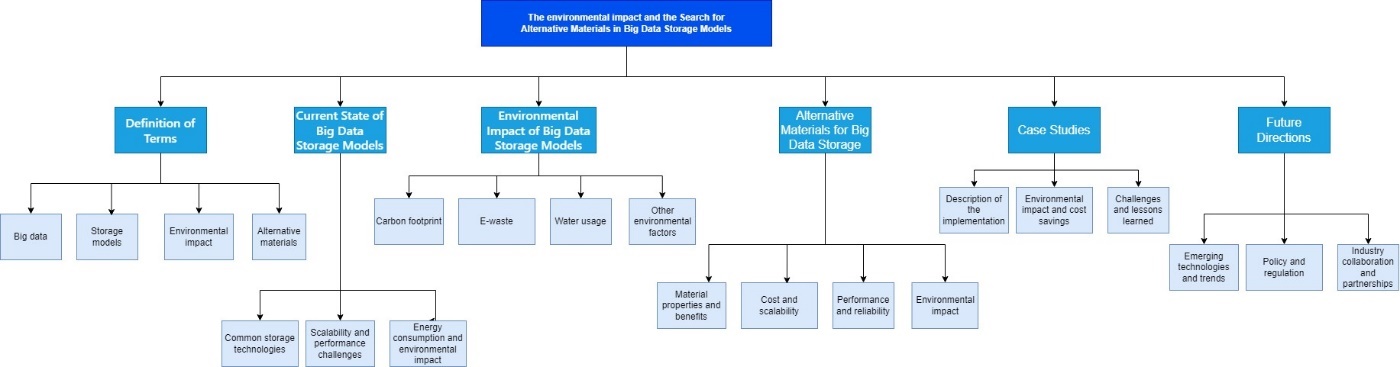


Figure 1: Work breakdown

* 1. **Time estimation**

|  |  |
| --- | --- |
| Activity | Time estimation |
| Definition of Terms | 1 week |
| Current State of Big Data Storage Models | 2 weeks |
| Environmental Impact of Big Data Storage Models | 3 weeks |
| Alternative Materials for Big Data Storage | 4 weeks |
| Case Studies | 4 weeks |
| Future Directions | 2 weeks |
| Total | 16 weeks |

* 1. **Identify milestones**

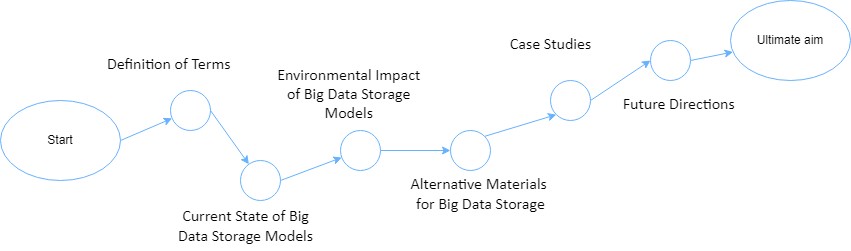


Figure 2: Milestones

* 1. **Grantchart**

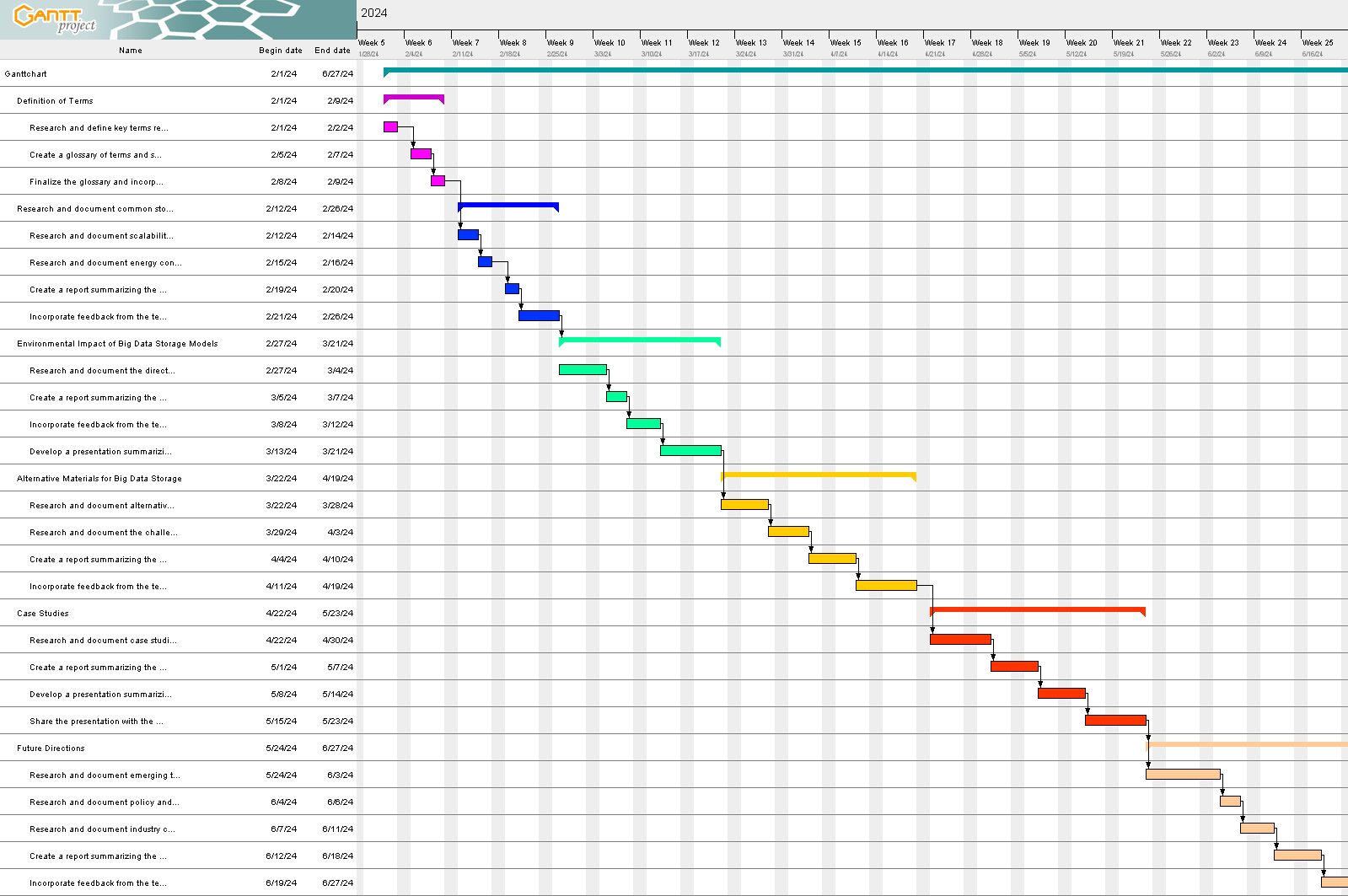


Figure 3: Grantchart

1. **Literature review**

During the research process on Environmental Impact and Search for Alternative Materials in Big Data Storage Model, some important and meaningful results were obtained, which are:

**Clear Awareness of the Problem:**

Through careful analysis and research, the research team has gained a clear and in-depth view of the environmental impact of today's big data storage models. This has helped reshape awareness of the need to find and apply alternative materials.

**Identifying Important Features of Alternative Materials:**

Through analyzing available alternative material options, the team identified important features that these materials needed to meet, including recyclability, sustainability, and recyclability. minimize environmental impact.

**Deep Understanding of Challenges and Opportunities:**

The research clearly reflects on the challenges and opportunities in finding and applying alternative materials in the big data storage model. This understanding has helped shape the strategy and direction for future research and development.

**Suggestions and Guidelines for Further Research:**

The results of the study provide a solid basis for continued research in this area. Suggested research methods, approaches, and development models have been proposed to promote progress and innovation in this field.

**Contribution to the Research Community and Social Community:**

By providing new insights and useful information, this research has contributed to the development of the research community, helping to increase awareness and action on environmental issues in the data storage industry. Whether.

**P7 Consider alternative research methodologies and lessons learnt in view of the outcomes.**

1. **Mistake during your research process**

During the research process, several mistakes were encountered, which provided valuable lessons for future endeavors. These mistakes spanned both primary and secondary research methodologies, highlighting areas for improvement and refinement in future projects. Below are some of the notable mistakes identified during the research process:

* 1. **Mistake in research primary**

During the primary research, I used interview and survey methods, which played an important role in collecting data from the participants. These two methods provide opportunities to interact directly and gain detailed information about research issues. However, using those two methods faces some difficulties, so the collected data is still lacking. Below are the limitations of the above two methods

Interview:

Lack of diverse sample: Due to the real-life nature of life and limited resources, interviews may not include a sufficiently diverse sample, resulting in an inability to represent the entire population or target group.

Lack of uniformity in data collection: Interviewer subjectivity can lead to inconsistency in data collection, especially when using many different interviewers.

Risk of bias on the part of the interviewer: Bias can appear when the interviewer has his or her own views or expectations, leading to influencing the information collected.

Subjectivity in data analysis: Data analysis from interviews can be influenced by the analyst's subjectivity, leading to misunderstandings or inaccuracies.

Survey

Lack of response: There may be a high percentage of survey participants who do not complete or do not answer some questions, leading to gaps in the data collected.

Participant bias: Participants may have a tendency to answer dishonestly or select answers in a certain direction, leading to bias in the collected data.

Lack of representative random sample: Without an accurate random sample plan, the data collected from the survey may not be representative of the entire population or target group.

Lack of accuracy in recording information: Participants may not remember or be inaccurate in recording information, especially when using inconsistent recording media such as paper forms or online .

* 1. **Mistake in secondary research**

In secondary research, I use document synthesis and content analysis methods. Below are the mistakes of the two methods during the research process that I noticed

* Limitations on Detail and Diversity: Document synthesis and content analysis methods may not provide sufficient detail and diversity of environmental impacts and alternative materials in the circulation model. large data storage. Documents may not cover specific aspects or may not provide enough data for analysis.
* Risk of Bias and Bias: There is a high risk of bias and bias in data compiled from different sources. Documentary sources may contain subjective views and statements from different authors, organizations or countries, leading to uncertainty about the objectivity and reliability of the data.
* Shortcomings in Freshness and Updates: These methods may not ensure the freshness and up-to-dateness of information, especially in the field of technology and environment where developments and changes occur rapidly. quickly. Data from old documents may not reflect the current situation and new trends.
* Responsiveness and Engagement Shortcomings: These methods do not provide opportunities for direct feedback and interaction with the research community or other stakeholders. This may reduce community interaction and participation in the research process.
* Risk of Lack of Detail and Complexity: These methods may not be able to capture detailed and complex information about the relationships between factors and variables in the field of big data storage, reduces the ability to have a deep and comprehensive understanding of the research problem.

1. **Reflection on the result of the research**

When reflecting on the results of the study "Environmental Impact and Search for Alternative Materials in Big Data Storage Models", it can be observed that limitations and mistakes in the research process had an impact. influence the understanding and final outcome of the project. Here are some points to consider in reflecting on the results of the study:

* Insight into Environmental Impact and Alternative Materials: Despite limitations in data collection and analysis, the study provides an overview of the environmental impact of the traffic model. Big data storage and the search for alternative materials. These results can assist in identifying key and potential problems in this field.
* Identify Limitations and Gaps: By reflecting on limitations and errors during the research process, the research team can better understand the strengths and weaknesses of the project. This helps improve research methods and develop future research strategies.
* Proposing Future Directions: Based on the results obtained and reflecting on limitations, the research team can propose further directions for future research. This may include using different research methods, expanding the scope of the research, or increasing engagement with the research community and stakeholders.
* Value in Decisions and Policy: Despite its limitations, the results of the study can still provide important information to support decisions and policies in the areas of big data storage and environmental protection. This may include suggesting improvements or developing new policies based on insights from research.

In summary, despite its limitations and mistakes, the research still provides value in understanding the environmental impact and finding alternative materials in the big data storage paradigm. Reflecting on the results of the study helps the research team improve and develop in the future to achieve better and more reliable results.

1. **Alternative research methodologies and improvement in futures**
   1. **Experimental Research in environmental sustainability**

Experimental research offers a robust methodology for investigating environmental sustainability issues, including those related to big data storage models. By conducting controlled experiments, researchers can manipulate variables to assess their impact on environmental factors and identify alternative materials or practices that promote sustainability. Here are some key aspects and potential improvements for future experimental research in this domain:

* Controlled Environment: Experimental research allows for precise control over variables, enabling researchers to isolate the effects of specific factors on environmental sustainability. Future studies can benefit from ensuring the replicability and consistency of experimental conditions to enhance the reliability of findings.
* Measurement and Monitoring: Implementing advanced measurement techniques and monitoring systems can provide real-time data on environmental indicators during experiments. This approach allows researchers to accurately quantify the impact of different materials or practices on environmental sustainability metrics.
* Simulation Modeling: Integrating simulation modeling techniques with experimental research enables researchers to simulate various scenarios and assess their environmental implications. This approach facilitates the exploration of complex interactions and uncertainties, providing valuable insights for decision-making.
* Interdisciplinary Collaboration: Collaborating with experts from diverse disciplines, such as environmental science, materials engineering, and computer science, can enrich experimental research in environmental sustainability. By leveraging interdisciplinary perspectives and methodologies, researchers can address multifaceted challenges more effectively.
* Community Engagement: Involving local communities and stakeholders in experimental research enhances the relevance and applicability of findings. Engaging stakeholders throughout the research process fosters mutual learning and facilitates the co-design of sustainable solutions tailored to specific contexts.
  1. **Future Research Improvements**

In future research endeavors focusing on environmental impacts and alternative materials in big data storage models, several improvements can be implemented to enhance the quality and relevance of findings:

* Longitudinal Studies: Conducting longitudinal studies over extended periods allows researchers to track changes in environmental impacts and material usage trends over time. This approach provides a comprehensive understanding of evolving patterns and enables the assessment of long-term sustainability implications.
* Integrated Assessment Approaches: Adopting integrated assessment approaches that combine quantitative and qualitative methods can capture the multifaceted nature of environmental sustainability challenges. By integrating diverse data sources and analytical techniques, researchers can generate more nuanced insights and inform holistic decision-making.
* Technological Innovations: Embracing technological innovations, such as remote sensing technologies, IoT devices, and advanced data analytics tools, enhances the capacity to monitor and analyze environmental parameters in real-time. Leveraging cutting-edge technologies enables researchers to collect high-resolution data and detect subtle changes in environmental conditions more effectively.
* Policy and Governance Analysis: Incorporating policy and governance analysis into research frameworks allows for a deeper understanding of the regulatory landscape and its implications for environmental sustainability. By examining policy frameworks, regulations, and governance structures, researchers can identify barriers and opportunities for promoting sustainable practices in big data storage.
  1. **Case studies**
     1. **Improvement in Future Case studies**
* To address the identified limitations and improve future case studies, several strategies can be implemented:
* Diverse Case Selection: Select a diverse range of case studies representing various geographical locations, industry sectors, and organizational contexts to enhance the generalizability of findings.
* In-depth Qualitative Analysis: Conduct thorough qualitative analysis to uncover underlying drivers, barriers, and dynamics shaping environmental sustainability practices within each case study.
* Cross-case Comparison: Perform cross-case comparisons to identify common patterns, differences, and best practices across multiple cases, facilitating the extraction of transferable lessons and insights
* Stakeholder Engagement: Engage stakeholders throughout the case study process to promote collaboration, co-learning, and knowledge co-creation, ensuring the relevance and applicability of research findings
* Integration of Quantitative Methods: Integrate quantitative methods alongside qualitative approaches to complement the depth of qualitative analysis with quantitative data, providing a more comprehensive understanding of the research problem.
* By implementing these improvements, future case studies can enhance their validity, reliability, and impact, contributing to a deeper understanding of environmental impacts and alternative materials in big data storage models.

1. **Lesson learned in view the outcome** 
   1. **Achieved Results**

In this section, we delve into the outcomes achieved through the research on environmental impacts and alternative materials in big data storage models. Despite encountering challenges, valuable insights were obtained from both primary and secondary research methods.

**Primary Research Findings:**

The primary research, utilizing interview and survey methods, provided firsthand insights into the environmental impacts associated with current data storage practices and the feasibility of alternative materials. Through interviews with industry experts and stakeholders, detailed information was gathered regarding the challenges and opportunities in adopting sustainable practices in big data storage.

Surveys complemented the qualitative data by quantifying responses and identifying trends among participants. While the survey response rate was satisfactory, there were instances of non-responses and incomplete data, posing challenges to data analysis.

**Secondary Research Insights:**

Secondary research, employing document synthesis and content analysis methods, unearthed existing literature, reports, and studies related to environmental sustainability in big data storage. These sources offered a wealth of information, shedding light on various aspects such as environmental impacts, emerging technologies, and alternative materials.

However, limitations were observed in terms of detail, diversity, bias, and currency of the sources. Despite these shortcomings, secondary research provided valuable context and supplemented the findings from primary research.

* 1. **Lessons Learned in view the outcome**

The research outcome unveiled several lessons that can guide future endeavors in environmental sustainability and big data storage. These lessons stem from the challenges faced during data collection, analysis, and interpretation, as well as the strengths and weaknesses of the research methods employed.

**Importance of Diverse Sampling:**

One key lesson learned is the significance of diverse sampling in research. The lack of diversity in the sample population can skew results and limit the generalizability of findings. Future research efforts should prioritize inclusivity and aim to capture a broad spectrum of perspectives and experiences.

**Mitigating Bias in Data Collection:**

Bias, whether from interviewers, participants, or sources, can significantly impact research outcomes. Implementing strategies to mitigate bias, such as standardized protocols, anonymity, and random sampling, is essential for ensuring the reliability and validity of data collected.

**Integration of Quantitative and Qualitative Approaches:**

Combining quantitative and qualitative research methods offers a comprehensive understanding of complex phenomena. While quantitative methods provide statistical rigor, qualitative approaches delve deeper into underlying factors and perspectives, enriching the research findings.

**Continuous Improvement in Research Practices:**

Continuous improvement is key to advancing research methodologies and practices. Reflecting on challenges and shortcomings, and incorporating feedback from stakeholders, enables researchers to refine their approaches and enhance the quality of future research endeavors.

**Stakeholder Engagement for Relevance and Applicability:**

Engaging stakeholders throughout the research process promotes collaboration, fosters trust, and ensures the relevance and applicability of research findings to real-world contexts. Building partnerships with industry, academia, and community stakeholders enhances the impact of research outcomes.

* 1. **Evaluation of the results**

The evaluation of research results involves a critical analysis of strengths, weaknesses, opportunities, and threats associated with the findings. This assessment provides insights into the overall efficacy and relevance of the research outcomes.

**Strengths:**

* The utilization of both primary and secondary research methods allowed for a comprehensive exploration of the research topic.
* The findings contribute to the existing body of knowledge on environmental sustainability in big data storage.
* The identification of challenges and limitations offers opportunities for future research and innovation in the field.

**Weaknesses:**

* Limitations in sample diversity, data accuracy, and potential biases may affect the validity and reliability of the findings.
* Constraints in resource availability and time constraints may have impacted the depth and scope of the research.

**Opportunities:**

* The identified challenges present opportunities for further investigation and refinement of research methodologies.
* Emerging trends and developments in technology and environmental sustainability offer avenues for future research exploration.

**Threats:**

* External factors such as changes in regulations, funding, and industry dynamics may pose challenges to the implementation of research recommendations.
* Rapid advancements in technology and environmental factors necessitate ongoing adaptation and flexibility in research approaches.
  1. **Key Takeaways**

Drawing insights from the research outcome, several key takeaways emerge that can guide future research endeavors and inform practice in the field of environmental sustainability and big data storage:

**Holistic Approach:**

Adopting a holistic approach that integrates quantitative and qualitative methods enhances the depth and breadth of research findings.

**Continuous Improvement:**

Embracing a culture of continuous improvement enables researchers to refine methodologies and address challenges, thereby enhancing the credibility and relevance of research outcomes.

**Stakeholder Engagement:**

Engaging stakeholders throughout the research process fosters collaboration, ensures the applicability of findings, and promotes knowledge exchange.

**Ethical Considerations:**

Upholding ethical standards in data collection, analysis, and dissemination is essential for maintaining the integrity and trustworthiness of research outcomes.

1. **Conclusion**
   1. **Limitations and Recommendations for future work**

Despite the valuable insights gained from the research on environmental impacts and alternative materials in big data storage models, certain limitations were encountered, suggesting areas for improvement in future endeavors. Additionally, recommendations for future research work are outlined to address these limitations and further advance knowledge in the field.

**Limitations:**

* Sample Diversity: One of the primary limitations of the research was the lack of diversity in the sample population. Future studies should aim to incorporate a more diverse range of participants representing various demographics, industries, and geographical locations to ensure the generalizability of findings.
* Data Accuracy: Accuracy in data collection and recording posed challenges, particularly in the primary research phase. Improving data collection methodologies, such as implementing standardized protocols and utilizing digital recording tools, can enhance the accuracy and reliability of data
* Bias Mitigation: Despite efforts to mitigate bias, inherent biases in data collection methods, such as interviewer bias and participant bias, persisted. Future research should employ rigorous bias mitigation strategies, such as random sampling and anonymization, to minimize the impact of biases on research outcomes.
* Resource Constraints: Resource constraints, including time and funding limitations, hindered the depth and scope of the research. Securing adequate resources and support for future research endeavors is crucial to conducting comprehensive investigations in this complex field.

**Recommendations for Future Work:**

* Longitudinal Studies: Conducting longitudinal studies to track environmental impacts and technological advancements in big data storage over time can provide valuable insights into evolving trends and patterns.
* Multi-method Approaches: Integrating multiple research methods, such as case studies, experiments, and simulations, can offer a more comprehensive understanding of environmental sustainability in big data storage models.
* Collaborative Research Initiatives: Collaborating with industry partners, academic institutions, and governmental agencies can facilitate access to resources, expertise, and real-world data, enhancing the relevance and impact of research outcomes.
* Policy Analysis: Analyzing policy frameworks and regulations related to environmental sustainability and data storage can inform the development of evidence-based policies and guidelines to promote sustainable practices in the industry.
* Community Engagement: Engaging stakeholders, including communities, advocacy groups, and end-users, in the research process fosters inclusivity and ensures that research outcomes address real-world needs and concerns.
* Technological Innovation: Exploring innovative technologies, such as renewable energy-powered data centers and biodegradable storage materials, can drive sustainable solutions in the field of big data storage.
  1. **Reflection**

Reflecting on the research journey provides insights into the strengths, weaknesses, and lessons learned throughout the process. This reflection offers an opportunity to assess the impact of the research and identify areas for personal and professional growth.

**Strengths:**

* Interdisciplinary Approach: The research adopted an interdisciplinary approach, combining insights from environmental science, technology, and social sciences to address complex issues in big data storage.
* Stakeholder Engagement: Engaging stakeholders throughout the research process promoted collaboration, generated diverse perspectives, and ensured the relevance of research outcomes.
* Knowledge Contribution: The research contributed to advancing knowledge in the field of environmental sustainability in big data storage models, offering practical insights and recommendations for industry practitioners and policymakers.

**Weaknesses:**

* Methodological Challenges: Methodological challenges, including sample limitations and data accuracy issues, posed constraints on the validity and reliability of research findings.
* Resource Constraints: Resource constraints, such as time and funding limitations, restricted the depth and breadth of the research, impacting the comprehensiveness of the findings.

**Lessons Learned:**

* Continuous Improvement: Embracing a mindset of continuous improvement is essential for refining research methodologies, addressing limitations, and advancing knowledge in the field.
* Adaptability: Flexibility and adaptability are key attributes in navigating the complexities and uncertainties inherent in research endeavors, enabling researchers to overcome challenges and seize opportunities.
* Ethical Considerations: Upholding ethical standards in research practices, including data collection, analysis, and dissemination, is paramount for maintaining integrity and trustworthiness.

1. **Conclusion**

In conclusion, the reflection on the effectiveness of research methods applied in our computing research project has provided valuable insights into the strengths, weaknesses, and lessons learned from our approach. Through the utilization of primary research methods such as interviews and surveys, we were able to gather firsthand data and gain detailed insights into our research issues. However, challenges such as sample diversity and potential biases highlighted the need for careful consideration and mitigation strategies in future research endeavors.

Additionally, secondary research methods such as document synthesis and content analysis proved invaluable in providing context, background information, and insights into our research topic. While these methods offered a comprehensive review of existing literature, limitations such as the lack of detail and potential biases underscored the importance of critically evaluating and corroborating findings from multiple sources.

Moving forward, alternative research methodologies such as experimental research in environmental sustainability could enhance our understanding of environmental impacts and alternative materials in big data storage models. By considering these alternative approaches and incorporating lessons learned from our research, we can refine our research strategies, improve the rigor of our investigations, and maximize the impact of our scholarly endeavors in the field of computing research.

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