



Research Methodology



Research Paper Writing and Presentation

Structure, Writing, and Effective Presentation



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Introduction



- Importance of Research Paper Writing and Presentation
- Connection to the Research Methodology Course



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Objectives



- Understand the structure of a research paper
- Learn how to write key sections (abstract, introduction, literature review, methodology, results)
- Enhance skills for effective research paper presentations

e-Adhyayan
Liberating Minds!



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Structure of a Research Paper

- Title and Authors:
 - Concise, informative title; acknowledges all contributing authors.
- Abstract:
 - Brief summary highlighting objectives, methods, results, and conclusions.
- Introduction:
 - Sets stage, introduces problem, outlines study objectives.
- Literature Review:
 - Contextualizes research, identifies gaps, synthesizes relevant studies.



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 - Contextualizes research, identifies gaps, synthesizes relevant studies.
- **Methodology:**
 - Details research design, participants, materials, ensures rigor.
- **Results:**
 - Presents findings objectively using tables, figures, statistics.
- **Discussion:**
 - Interprets results, explores implications, relates findings to literature.
- **Conclusion:**
 - Summarizes key findings, discusses implications, suggests future research.
- **References:**
 - Acknowledges sources, demonstrates academic integrity, guides further exploration.

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Abstract

- Summary encapsulating the core elements of your research
- Key Components
 - (Objective, Methods, Results, Conclusion)
- Tips for Writing an Effective Abstract
 - Clarity and Brevity
 - Use of Keywords
 - Accuracy
 - Write Last

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Abstract:

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Predictive Modeling of Customer Churn in E-commerce: A Data Science Approach

Abstract:

In the rapidly evolving landscape of e-commerce, customer churn poses a significant challenge for businesses seeking to retain their customer base. This study employs advanced data science techniques to develop a predictive model for identifying and understanding factors contributing to customer churn. The research utilizes a dataset comprising transactional and behavioral data from a leading e-commerce platform over a 12-month period. Machine learning algorithms, including logistic regression, decision trees, and ensemble methods, are employed to analyze customer interactions, purchase history, and engagement patterns.

Results reveal key predictors of customer churn, including frequency of purchases, time spent on the platform, and response to promotional offers. The developed model achieves a high predictive accuracy of 85%, allowing for proactive identification of potential churners. Moreover, the study explores the interpretability of the model through feature importance analysis, shedding light on the underlying mechanisms driving customer attrition. Insights derived from this research empower e-commerce businesses to implement targeted strategies for customer retention, thereby optimizing marketing efforts and improving overall customer satisfaction.

This research not only contributes to the field of data science in the context of customer churn prediction but also provides actionable insights for businesses seeking to leverage data-driven approaches to enhance customer loyalty in the competitive e-commerce landscape.

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Introduction

- It Guides, Establishes Relevance, Frames Research, Academic or Practical Significance
- Components
 - Background:
 - Contextualization, Trends, Existing Knowledge, Setting
 - Problem Statement:
 - Specific Issue, Relevance, Urgency, Framing
 - Research Questions/Hypotheses:
 - Guiding Inquiries, Hypothesis Formulation, Roadmap
 - Objectives:
 - Specific Goals, Outcomes, Direction, Alignment
- Examples

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Lecture 1: Introduction to Research Methods (www.raje...)

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Example:

"With the advent of artificial intelligence in healthcare, this research investigates the ethical implications of using predictive algorithms in patient diagnosis. As technology continues to reshape medical practices, understanding the ethical considerations is paramount to ensuring responsible and unbiased use of AI in the healthcare domain."

Setting

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Evaluating and Example

"Energizing Tomorrow: Exploring the Potential of Advanced Battery Technologies for Sustainable Energy Storage"

Introduction: Welcome to an exploration of the intricate realm of sustainable energy and the critical need for advanced battery technologies. In a world grappling with escalating energy demands, the backdrop of this study is set against the pressing challenge of efficient energy storage. As we embark on this research journey, the components of the introduction—the background, problem statement, research questions, and objectives—will collectively illuminate the path toward understanding and addressing this contemporary issue.

Background: The canvas of sustainable energy unfolds against a backdrop of global energy dynamics. Existing knowledge underscores the urgency of developing cost-effective and environmentally friendly storage methods. Trends in energy consumption and emerging technologies shape the context for our inquiry into advanced battery technologies.

Problem Statement: Amidst the advancements in renewable energy, a distinct gap looms—the need for efficient energy storage solutions. Current technologies fall short in providing scalable, sustainable, and economically viable options. This problem statement establishes the research's relevance in a world increasingly reliant on clean and reliable energy sources.

Research Questions/Hypotheses: To navigate this uncharted territory, our inquiry is guided by fundamental questions. How can advanced battery technologies revolutionize energy storage? What are the key challenges in their widespread adoption? These research questions lay the foundation for our exploration and set the tone for hypothesis formulation.

Objectives: Within this tapestry, the study unfolds with clear objectives. Firstly, to assess the potential of advanced battery technologies in transforming energy storage. Secondly, to identify and address challenges hindering their large-scale implementation. These objectives define our goals, providing direction and purpose to the research endeavour.

As we venture into the intricacies of sustainable energy and advanced battery technologies, the introduction serves not only to orientate but to underscore the significance of our quest. The background establishes the context, the problem statement sharpens our focus, research questions guide our inquiry and objectives chart the course for a meaningful exploration into the future of energy storage.

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Advanced Battery Storage"

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guides our inquiry
energy storage.

1. Comprehensive Contextualization:

- Establishes a rich context for sustainable energy, integrating trends and global dynamics.

2. Clearly Defined Problem Statement:

- Articulates a precise gap, emphasizing the urgency and relevance of energy storage.

3. Focused Research Questions:

- Crafted questions guide the study, framing the investigation and providing a roadmap.

4. Purposeful Objectives:

- Specific and aligned goals provide direction, contributing to the overall research purpose.

5. Engaging Title:

- The title, "Energizing Tomorrow," captures essence and sparks interest in potential readers.

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Evaluating and Examining Advanced Battery Technologies for Sustainable Energy Storage

"Energizing Tomorrow: Exploring the Potential of Emerging Technologies for Sustainable Energy Storage"

Introduction: Welcome to an exploration of the intricate realm of advanced battery technologies. In a world grappling with the need for sustainable energy storage, the backdrop of this study is set against the pressing challenge of efficiency and cost-effectiveness. Through this research journey, the components of the introduction—title, subtitle, research questions, and objectives—will collectively illuminate the path forward in addressing this contemporary issue.

Background: The canvas of sustainable energy unfolds against a backdrop of global environmental concerns. Existing knowledge underscores the urgency of developing cost-effective and efficient energy storage methods. Trends in energy consumption and emerging technologies provide the impetus for this inquiry into advanced battery technologies.

Problem Statement: Amidst the advancements in renewable energy sources, there is a critical need for efficient energy storage solutions. Current technologies fall short in terms of both performance and cost, leaving a gap for more reliable and economically viable options. This problem statement establishes the rationale for this research, driven by the growing demand for energy systems that are increasingly reliant on clean and reliable energy sources.

Research Questions/Hypotheses: To navigate this uncharted territory, the study poses several fundamental questions. How can advanced battery technologies revolutionize energy storage? What are the key challenges in their widespread adoption? These research questions guide the direction of the exploration and set the tone for hypothesis formulation.

Objectives: Within this tapestry, the study unfolds with clear objectives. The primary objective is to evaluate the potential of advanced battery technologies in transforming energy storage. Secondary objectives include addressing the challenges hindering their large-scale implementation. These objectives define the scope and direction to the research endeavour.

As we venture into the intricate landscape of advanced battery technologies, this introduction serves not only to establish the context but also to introduce the significance of the research focus, the research questions, and objectives chart the course for the exploration ahead.



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Evaluating and Example

"Energizing Tomorrow: Exploring the Potential of Advanced Battery Technologies for Sustainable Energy Storage"

Introduction: Welcome to an exploration of the intricate realm of sustainable energy and the need for advanced battery technologies. In a world grappling with escalating energy demands, the backdrop of this study is set against the pressing challenge of efficient energy storage. As we embark on this research journey, the components of the introduction—the background, problem statement, research questions, and objectives—will collectively illuminate the path toward understanding and addressing this contemporary issue.

Background: The canvas of sustainable energy unfolds against a backdrop of global energy consumption patterns. Existing knowledge underscores the urgency of developing cost-effective and environmentally friendly energy storage methods. Trends in energy consumption and emerging technologies shape the context of our inquiry into advanced battery technologies.

Problem Statement: Amidst the advancements in renewable energy, a distinct gap looms for efficient energy storage solutions. Current technologies fall short in providing scalable, sustainable, and economically viable options. This problem statement establishes the research's relevance in the context of a world increasingly reliant on clean and reliable energy sources.

Research Questions/Hypotheses: To navigate this uncharted territory, our inquiry is guided by fundamental questions. How can advanced battery technologies revolutionize energy storage? What are the key challenges in their widespread adoption? These research questions lay the foundation for our exploration and set the tone for hypothesis formulation.

Objectives: Within this tapestry, the study unfolds with clear objectives. Firstly, to assess the potential of advanced battery technologies in transforming energy storage. Secondly, to identify and mitigate challenges hindering their large-scale implementation. These objectives define our goals, providing direction and purpose to the research endeavour.

As we venture into the intricacies of sustainable energy and advanced battery technologies, this introduction serves not only to orientate but to underscore the significance of our quest. The background provides context, the problem statement sharpens our focus, research questions guide our inquiry, and objectives chart the course for a meaningful exploration into the future of energy storage.



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"Arrow: Exploring the Potential of Advanced Battery Technologies for Sustainable Energy Storage"

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Technologies for Sustainable Energy Storage"

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The canvas of sustainable energy unfolds against a backdrop of global energy dynamics. This introduction underscores the urgency of developing cost-effective and environmentally friendly solutions. The trends in energy consumption and emerging technologies shape the context for our focus on advanced battery technologies.

Amidst the advancements in renewable energy, a distinct gap looms—the need for reliable storage solutions. Current technologies fall short in providing scalable, sustainable, and cost-effective options. This problem statement establishes the research's relevance in a world where clean and reliable energy sources are crucial.

Hypotheses: To navigate this uncharted territory, our inquiry is guided by several research questions. How can advanced battery technologies revolutionize energy storage? What are the key factors influencing their widespread adoption? These research questions lay the foundation for our methodology and provide a clear direction for hypothesis formulation.

In this tapestry, the study unfolds with clear objectives. Firstly, to assess the potential of advanced battery technologies in transforming energy storage. Secondly, to identify and address the challenges in their large-scale implementation. These objectives define our goals, providing a clear roadmap for the research endeavour.

As we continue to explore the intricacies of sustainable energy and advanced battery technologies, the introduction serves not only to orientate but to underscore the significance of our quest. The background, research questions, and problem statement sharpen our focus, research questions guide our inquiry, and the objectives chart the course for a meaningful exploration into the future of energy storage.

1. Comprehensive Context

- Establishes a clear context by integrating relevant background information.

2. Clearly Defined Problem Statement

- Articulates a specific problem statement that highlights the urgency and importance of the research.

3. Focused Research Questions

- Crafted questions that guide the investigation and contribute to the problem statement.

4. Purposeful Objectives

- Specific and measurable objectives that contribute to the overall research goals.

5. Engaging Title:

- The title, "Energy Storage Solutions," captures the essence and scope of the research.

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Literature Review



- It is critical examination of existing scholarship relevant to the research topic
- Components
 - Scope: defines review boundaries.
 - Relevant studies: summarize existing research.
 - Gaps: highlight shortcomings, set stage for contribution.
- Tips for Writing an Effective Literature Review
 - Thematic organization.
 - Critical analysis of studies.
 - Synthesis of findings.
 - Clarity and conciseness.
 - Integration with research objectives.



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Example Literature Review:

Impact of social media on Mental Health Among Adolescents

Literature Review:

Scope: The literature surrounding the impact of social media on the mental health of adolescents spans a wide range of disciplines, including psychology, sociology, and communication studies. This review focuses on studies conducted within the past decade, examining the evolving landscape of social media and its potential effects on the mental well-being of adolescents.

Relevant Studies: Numerous studies have explored the relationship between social media usage and mental health outcomes among adolescents. Smith et al. (2017) conducted a longitudinal study revealing a correlation between excessive social media use and increased symptoms of anxiety and depression. In a cross-sectional analysis, Jones and Wang (2019) found a significant association between cyberbullying on social media platforms and heightened levels of stress among adolescents.

Gaps in the Literature: While existing research sheds light on the negative impact of social media, there is a notable gap in understanding the nuanced ways in which positive online interactions may contribute to adolescent mental well-being. Additionally, few studies have explored the long-term effects and potential mitigating factors that could buffer the negative consequences of excessive social media use.

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Evaluation

Strengths:

1. Clear Scope:

- Defined focus on adolescent mental health and social media impact.

2. Relevant Studies:

- Cites recent and varied studies, enhancing comprehensiveness.

3. Identification of Gaps:

- Effectively pinpoints gaps in understanding positive interactions and long-term effects.

4. Practical Tips:

- Tips for an effective literature review are practical and aligned.

Areas for Improvement:

1. Depth of Analysis:

- Needs deeper analysis of each study's methodologies and limitations.

2. Synthesis of Findings:

- Synthesis could be more explicit in connecting findings across studies.

3. Integration with Research Objectives:

- Strengthen connection between literature review and specific research objectives.

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Gaps in the Literature: While existing research sheds light on the negative impact of social media, there is a notable gap in understanding the nuanced ways in which positive online interactions may contribute to adolescent mental well-being. Additionally, few studies have explored the long-term effects and potential mitigating factors that could buffer the negative consequences of excessive social media use.

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Methodology

- It is systematic approach to execute and report research findings.
- Components
 - 1. Research Design: Specifies the overall plan (experimental or qualitative).
 - 2. Participants: Describes characteristics and inclusion criteria.
 - 3. Materials: Lists tools, instruments, or materials used.
 - 4. Procedure: Outlines step-by-step process from data collection to analysis.
- Rigor and Reproducibility
 - Rigor ensures accuracy; reproducibility validates a finding.

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- Rigor and Reproducibility
 - Rigor ensures accuracy; reproducibility validates and generalizes findings.

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Methodology



- It is systematic approach to execute and replicate the study.
- Components
 - 1. Research Design: Specifies the overall plan (experimental, correlational, qualitative).
 - 2. Participants: Describes characteristics and inclusion/exclusion criteria.
 - 3. Materials: Lists tools, instruments, or materials used for data collection.
 - 4. Procedure: Outlines step by step process from recruitment to analysis.
- Rigor and Reproducibility
 - Rigor ensures accuracy; reproducibility validates and generalizes findings.

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Example: Methodology

Methodology: Mindfulness Intervention for College Students' Stress

Design: Experimental (Randomized Control Trial).

Participants: College students (N=100), 18-25 years, diverse majors.

Intervention:

- 8-week mindfulness program.
- Daily 20-min sessions led by instructors.

Control Group: Continues regular activities.

Measures:

- Pre- and post-intervention PSS surveys.
- Mindfulness Diary for intervention group.

Procedures:

- Recruitment through campus channels.
- Random assignment using computer-generated method.
- Data collection: Pre, during (intervention), post.
- Statistical analysis (t-tests) for stress levels.

Rigor and Reproducibility:

- Adherence checks for mindfulness program.
- Detailed documentation for future replications.

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Results

- Communicates study outcomes, answers research questions and supports or refutes hypotheses.
- Presenting Data (Tables, Figures)
- Interpreting Results
 - Connection to Research Questions:
 - Clearly links results to specific questions.
 - Comparison with Hypotheses:
 - Assesses support or contradiction of hypotheses.
 - Discussion of Patterns and Trends:
 - Identifies and discusses data patterns.
 - Acknowledgment of Limitations:
 - Addresses study limitations or unexpected outcomes.



Results

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Table 1 de Scale (PS beginning 18.2, SD

2. Interv

Figure 1 a intervention compared

3. Statisti

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4. Pattern

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5. Limitat

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Evaluation

Strengths:

1. **Clear Design:** Strong experimental design.
2. **Detailed Intervention:** Well-documented 8-week mindfulness program.
3. **Diverse Participants:** Inclusion of diverse college students.
4. **Comprehensive Measures:** Pre- and post-intervention stress measures.
5. **Transparent Procedures:** Clear recruitment, random assignment, and data collection.
6. **Statistical Rigor:** T-tests for analysis.
7. **Documentation for Reproducibility:** Emphasis on detailed documentation.

Considerations:

1. **Adherence Monitoring:** Clarify methods.
2. **Control Group Engagement:** Specify monitoring.
3. **Instructor Qualifications:** Specify mindfulness instructors' qualifications.

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**Results**

The results of the study provide insight into the effectiveness of the mindfulness intervention in reducing stress levels among college students.

1. Descriptive Statistics:

Table 1 displays descriptive statistics for stress levels measured by the Perceived Stress Scale (PSS) in both the intervention and control groups. Mean stress scores at the beginning of the study were comparable between the groups (Intervention group $M = 18.2$, $SD = 3.5$; Control group $M = 18.0$, $SD = 3.2$).

2. Intervention Effectiveness:

Figure 1 illustrates the change in stress levels over the 8-week intervention period. The intervention group shows a noticeable decrease in stress scores ($M = 12.6$, $SD = 2.8$) compared to the control group ($M = 17.8$, $SD = 3.4$) at the post-intervention assessment.

3. Statistical Analysis:

A paired-sample t-test comparing pre- and post-intervention stress scores within the intervention group reveals a significant reduction in stress levels ($t(49) = 9.14$, $p < 0.001$). Additionally, an independent-sample t-test comparing post-intervention scores between the intervention and control groups demonstrates a significant difference ($t(98) = 5.32$, $p < 0.001$), indicating the effectiveness of the mindfulness intervention.

4. Patterns and Trends:

While the intervention group exhibited a consistent decrease in stress levels, individual differences were observed. Participants who actively engaged in daily mindfulness practice showed more substantial reductions in stress compared to those with lower adherence.

5. Limitations:

It is important to acknowledge limitations, including self-report bias in stress assessment and potential variability in engagement with mindfulness practices. Additionally, the study's short duration may not capture long-term effects.

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Effective Research Paper Presentations



- Importance of Clear Communication:

- It ensures that the audience comprehends the significance of the study, its methodology, and the obtained results

- Tips for Effective Presentations:

- Practice and Timing
- Visual Aids
- Engaging the Audience
- Handling Questions

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Additional Tips



- **Formatting and Style Guidelines**
 - Maintain polished formatting, ensure uniform font, margins, and spacing.
 - Use clear, concise language, maintain a scholarly and accessible tone.
- **Citation and Referencing**
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 - Seek feedback and revise iteratively for structure and clarity.



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An Extensible Dashboard Architecture For Visualizing Base And Analyzed Data

Abhishek Santra, Kunal Samant, Endrit Memeti, Enamul Karim
and Sharina Chakravarthy

IT Laboratory & CSE Department, I

Ask AI Assistant

Abstract. Any data analysis, especially the data often or in real-time, consists of at least three important synchronized components: i) figuring out what to infer (objectives), ii) analysis or computation of objectives, and iii) understanding of the results which may require drill-down and/or visualization. There is a lot of attention paid to the first two of the above components as part of research whereas the understanding as well as deriving actionable decisions is quite tricky. Visualization is an important step towards both understanding (even by non-experts) and inferring the actions that need to be taken. As an example, for Covid-19, knowing regions (say, at the county or state level) that have seen a spike or prone to a spike in cases in the near future may warrant additional actions with respect to gatherings, business opening hours, etc. This paper focuses on an extensible architecture for visualization of base as well as analyzed data.

This paper proposes a modular architecture of a dashboard for user-interaction, visualization management, and complex analysis of base data. The contributions of this paper are: i) extensibility of the architecture providing flexibility to add additional analysis, visualizations, and user interactions without changing the workflow, ii) decoupling of the functional modules to ease and speedup development by different groups, and iii) address efficiency issues for display.



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An Extensible Dashboard Architecture For Visualizing Base And Analyzed Data

Abhishek Santra, Kunal Samant, Endrit Memeti, Ehsunul Karim and Sharma Chakravarthy

IT Laboratory & CSE Department, UT Arlington

Abstract. Any data analysis, especially the data sets that may be changing often or in real-time, consists of at least three important synchronized components: i) figuring out what to infer (objectives), ii) analysis or computation of objectives, and iii) understanding of the results which may require drill-down and/or visualization. There is a lot of attention paid to the first two of the above components as part of research whereas the understanding as well as deriving actionable decisions is quite tricky. Visualization is an important step towards both understanding (even by non-experts) and inferring the actions that need to be taken. As an example, for Covid-19, knowing regions (say, at the county or state level) that have seen a spike or prone to a spike in cases in the near future may warrant additional actions with respect to gatherings, business opening hours, etc.. This paper focuses on an extensible architecture for visualization of base as well as analyzed data.

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To showcase the above, we present the implementation of a visualization dashboard, termed CoWiz++, (for Covid Wizard), and elaborate on how web-based user interaction and display components are interfaced seamlessly with the back-end module.

1 Motivation

Since early 2020, when the Covid-19 cases were first reported in the US, the virus has spread to all 3141 US counties^[1] in all states at different rates. As the hunt for a vaccine was launched, the number of cases has grown and leveled off based on the actions taken by different counties and states. Lack of a national policy and lack of synchronization between state and federal mandates have resulted in undesirable situations as compared to other coordinated efforts in other parts of the world. From a data collection viewpoint, a number of sources provide features associated with a confirmed report, such as infected case, hospitalization, death, or recovery making this data set complex with diverse metrics for different features to be monitored.



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⁷We focus on the USA as we have more accurate data for that although the pandemic is worldwide! Any country can be analyzed by swapping the data sets and with minor changes, such as prefectures in Japan instead of states.

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An Extensible Dashboard Architecture For Visualizing Base And Analyzed Data

Abhishek Santra, Kunal Samant, Endrit Memeti, Enamul Karim and Sharma Chakravarthy

IT Laboratory & CSE Department, UT Arlington

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This paper is organized as follows. Section 2 discusses related work. Section 3 details the architecture of the dashboard in terms of its modules. Section 4 presents base and objective-based analysis visualizations for the Covid-19 data set. Conclusions are in Section 5.

2 Related Work

Currently available online dashboards address category I and focus on reporting and visualizing daily cases on maps ([8][17][2]) or time series plots and statistical modeling ([3][5][4]). They are more focused on visualizing the base daily data. In contrast, drill-down of analysis of results is critical especially for complex data which has both structure and semantics. For example, it is not sufficient to know the identities of objects in a *community* (e.g., similar counties), but also additional details of the objects (e.g., population, per capita income etc.) Similarly, for a *centrality hub* or a *frequent substructure*. As we are using the MLNs as the data model, we also need to know the objects across layers and their inter-connections. From a computation/efficiency perspective, minimal information is used for analysis and the drill-down phase is used to expand upon to the desired extent. Our algorithms, especially the decoupling-based, make it easier to perform drill-down without any additional mappings back and forth for recreating the structure. Our schema generation also separates information needed for drill-down (Relations) and information needed for analysis (MLNs) from the same Enhanced Entity Relationship (EER) diagram. See [11] for details.

Visualization is not new and there exists a wide variety of tools for visualizing both base data, results, and drilled-down information in multiple ways [1][3][5]. Our focus, in this paper, is to make use of available tools in the best way possible and not propose new ones. For example, we have experimented with a wide variety of tools including, maps, individual graph and community visualization, animation of features in different ways, hovering to highlight data, and real-time data fetching and display, based on user input from a menu. The main contribution of visualization is our architecture with a common back end to drive different user interaction and visualization front ends. We have also paid attention to efficiency at the back end by caching pre-generated results and use of an efficient data structure for lookup [16].

Community detection algorithms have been extended to MLNs for identifying tightly knit groups of nodes based on different feature combinations ([2][13].) Al-


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Currently, many visualizations are used to plot the *peak, dip, and moving averages or colored maps* of Covid data, without much analysis on the base data or inclusion of associated data [3][4][5][8][7]. In other words, most of these are focused on the visualization of base data using simple statistical computations. However, for a comprehensive understanding of the spread of the pandemic (or any data for that matter), there is a need to *analyse and compare the effects of different events (mask requirement, social distancing, etc.) and demographics, in multiple geographical regions across different time periods.*

Broadly, visualizations for a data set can be classified into:

- I. Visualization using base data: There is no *analysis* involved in this visualization. Visualization includes primarily statistical information. Attributes and visualization alternatives can be selected by the end-user. Temporal ranges, animation, and other visualization parameters can also be chosen.
- II. Visualization using analyzed data: There is an *explicit analysis* that needs to be done on base and associated data prior to visualization. Visualization may include analysed results, drilled-down details of results, as well as visualization alternatives for them. Typically a model is used and objectives computed using that model.

Currently available online dashboards/visualizations primarily address category I above. For example, JHU (Johns Hopkins University) dashboard [3] shows a lot of base data and shows some of them also on a US map with circles indicating the numbers to get a relative understanding. Similarly, the WHO (World Health Organization) dashboard [7] shows base data for the world and a clickable map to show some base data for that country. For Covid data, most dashboard focus on either reporting and/or visualizing daily cases on maps ([8][1][7][2]) or time series plots and statistical information ([3][5][4]).

However, for category II, there is a need to model the base data which is dependent on the semantics of the data set. As an example, for Covid data, analysis is based on counties/states. We need to model *entities and relationships* in order to *analyze* and understand the data set from *multiple perspectives*. The result needs to be *visualized* to maximize understanding. In this paper, we use the Covid-19 data set as well as related information, such as population, average per capita income, education level etc. The focus is on an interactive dashboard architecture that is **modular, flexible, provides good response time, and supports both categories I and II above**.



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entities [20][24]. However, all these approaches *analyze a MLN by reducing it to a simple graph* either by aggregating all (or a subset of) layers or by considering the entire MLN as a whole, thus leading to loss of semantics as the entity and feature type information is lost.

3 Dashboard Architecture for Analysis and Visualization

As part of our research on big data analytics (using graphs and Multilayer Networks), we felt the need for drill-down and visualization of results for understanding and ground truth verification. The results of *aggregate analysis* as compared to statistics,

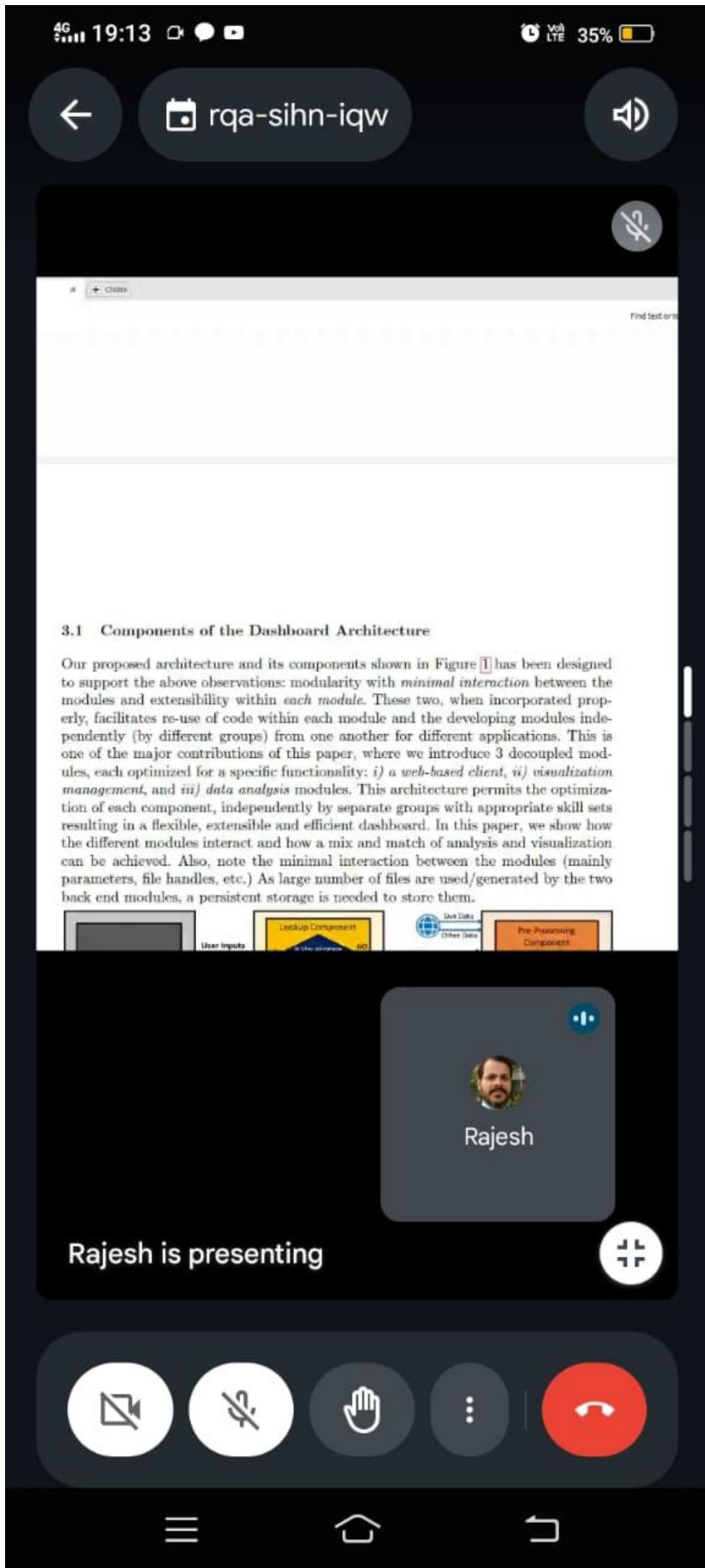
requires looking into more details (or drill-down). For example when a community of counties are computed or centrality nodes (cities) are identified, it is important to understand related information such as population density, per capita income,



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requires looking into more details (or drill-down). For example when a community of counties are computed or centrality nodes (cities) are identified, it is important to understand related information such as population density, per capita income, education level, etc. This was further exacerbated by the fact that the data sets we deal with have multiple types of entities, features, and relationships. So, drill-down and visualization of analyzed data along with additional details became pronounced.

When we started analyzing Covid data using our multilayer network analysis, it was important not only to drill-down, but also to visualize the data set and analysis results in multiple ways combining different aspects of the data set. For example, it was useful to visualize newly active cases in multiple states on a daily/weekly basis to see how they were changing. This could be done for multiple features, such as deaths, hospitalizations, etc. We also wanted to visualize similar regions in the country that had same/similar increase/decrease in active cases over the same time period. This would be very useful in understanding the effects of certain measures taken (e.g., masking, lockdown, social distancing) in different parts of the country. This essentially involved processing the same data under the categories I and II indicated above. This is also true for other data sets.

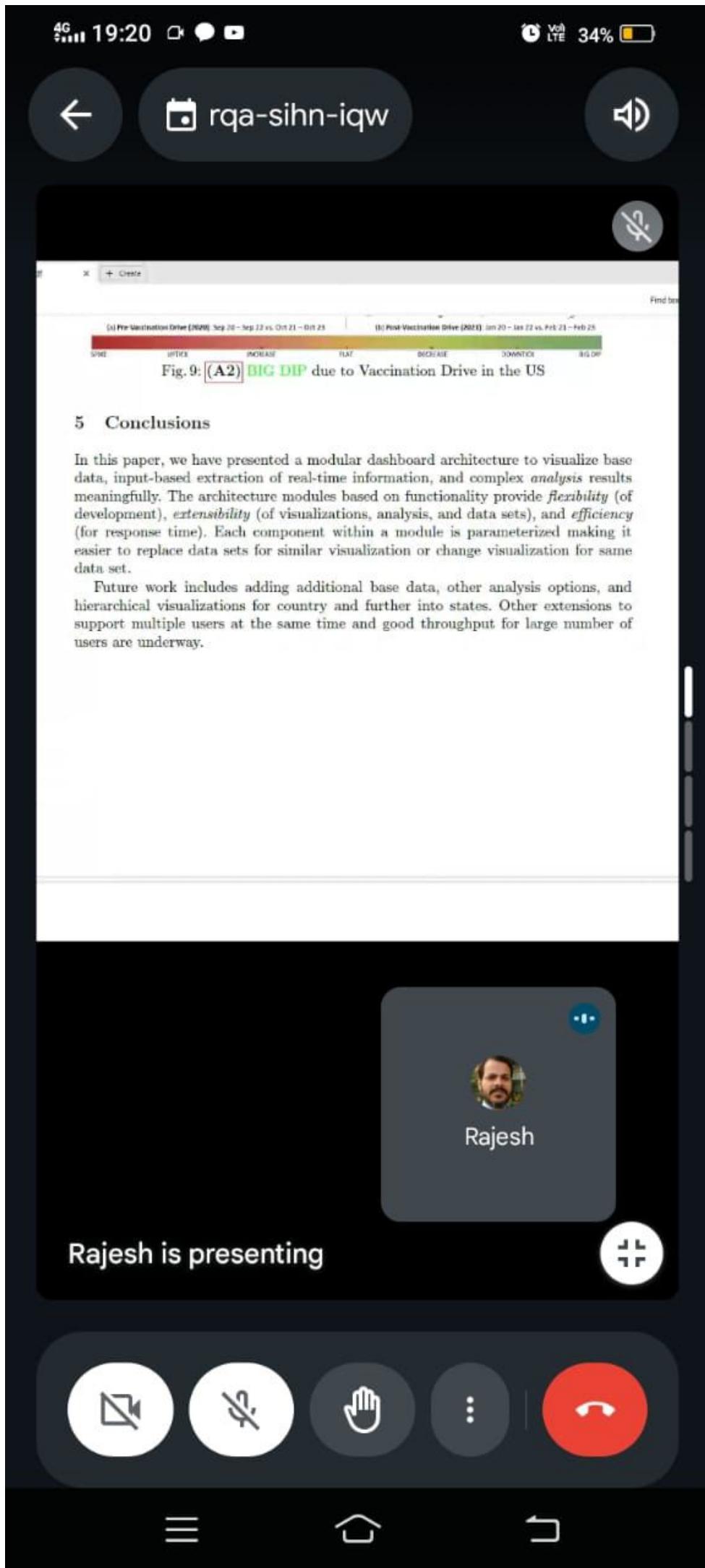
As we tried to develop a dashboard for Covid-19 visualization, we realized that the skill sets needed for analysis was significantly *different* from those needed for visualization/user-interaction. Analysis required a much deeper understanding of the knowledge discovery process including modeling of the data, coming up with objectives and computing them efficiently. On the other hand, visualization required a deeper understanding of the packages that can be used based on what and how we wanted to display. The client module needed yet another different set of skills in terms of



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3.1 Components of the Dashboard Architecture

Our proposed architecture and its components shown in Figure 1 has been designed to support the above observations: modularity with *minimal interaction* between the modules and extensibility within *each module*. These two, when incorporated properly, facilitates re-use of code within each module and the developing modules independently (by different groups) from one another for different applications. This is one of the major contributions of this paper, where we introduce 3 decoupled modules, each optimized for a specific functionality: *i) a web-based client, ii) visualization management, and iii) data analysis* modules. This architecture permits the optimization of each component, independently by separate groups with appropriate skill sets resulting in a flexible, extensible and efficient dashboard. In this paper, we show how the different modules interact and how a mix and match of analysis and visualization can be achieved. Also, note the minimal interaction between the modules (mainly parameters, file handles, etc.) As large number of files are used/generated by the two back end modules, a persistent storage is needed to store them.

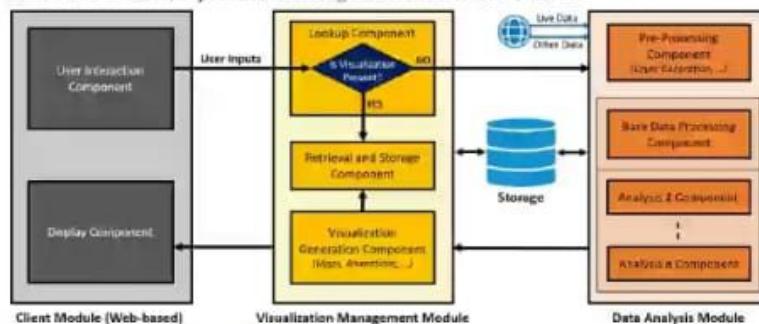


Fig. 1: Modular CoWiz++ Dashboard Architecture

There is a need for a closer synchronization between the client module and the back end visualization management module. For this to work correctly, the first step

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An Extensible Dashboard Architecture For Visualizing Base And Analyzed Data

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Abstract. Any data analysis, especially the data sets that may be changing often or in real-time, consists of at least three important synchronized components: i) figuring out what to infer (objectives), ii) analysis or computation of objectives, and iii) understanding of the results which may require drill-down and/or visualization. There is a lot of attention paid to the first two of the above components as part of research whereas the understanding as well as deriving actionable decisions is quite tricky. Visualization is an important step towards both understanding (even by non-experts) and inferring the actions that need to be taken. As an example, for Covid-19, knowing regions (say, at the county or state level) that have seen a spike or prone to a spike in cases in the near future may warrant additional actions with respect to gatherings, business opening hours, etc. This paper proposes a modular architecture for visualization management, and the main contributions of this paper are: i) extending the extensible dashboard architecture to add additional analysis, visualization, and management modules without changing the workflow, ii) decoupling the presentation layer from the dashboard development by different groups.

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Introduction



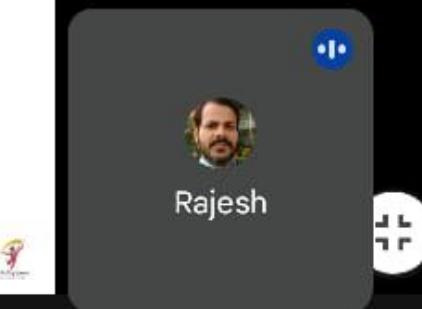
- Importance of Research Paper Writing and Presentation
- Connection to the Research Methodology Course



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Additional Tips



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- Maintain polished formatting, ensure uniform font, margins, and spacing.
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- Seek feedback and revise iteratively for structure and clarity.

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The screenshot shows a video call interface. At the top, there's a navigation bar with a back arrow, a search bar containing "rqa-sihh-iqw", a volume icon, and a microphone icon. Below this is a presentation slide with a dark background and white text. The text discusses the challenges of developing a dashboard for COVID-19 visualization, mentioning the need for different skill sets for analysis and visualization, and the importance of extensibility at the module level. A small thumbnail of a person with a beard and the name "Rajesh" are visible on the right side of the slide. At the bottom of the screen, there are several control icons: a camera icon (disabled), a microphone icon (disabled), a hand icon (highlighted in grey), a three-dot menu icon, and a red call-end icon. The bottom of the phone screen shows standard navigation icons.

results in multiple ways combining different aspects of the data set. For example, it was useful to visualize newly active cases in multiple states on a daily/weekly basis to see how they were changing. This could be done for multiple features, such as deaths, hospitalizations, etc. We also wanted to visualize similar regions in the country that had same/similar increase/decrease in active cases over the same time period. This would be very useful in understanding the effects of certain measures taken (e.g., masking, lockdown, social distancing) in different parts of the country. This essentially involved processing the same data under the categories I and II indicated above. This is also true for other data sets.

As we tried to develop a dashboard for Covid-19 visualization, we realized that the skill sets needed for analysis was significantly *different* from those needed for visualization/user-interaction. Analysis required a much deeper understanding of the knowledge discovery process including modeling of the data, coming up with objectives and computing them efficiently. On the other hand, visualization required a deeper understanding of the packages that can be used based on what and how we wanted to display. The client module needed yet another different set of skills in terms of layout, menu design, Java Script, and CSS. It seemed natural that these could be developed by different individuals or groups with appropriate skills if the dashboard can be *modularized along these functional components*. This primarily motivated our architecture shown in Figure 1.

The second thing we noticed was that most of the currently available visualization dashboards seem to be application and analysis specific. That is, if the data set description and application objectives change over a period of time, then the entire system has to be re-built. Although there is likely to be a separation between the client and back end module, having a single back end module seemed to defeat extensibility in addition to modularity. This would create bottlenecks for progress making the development process quite inefficient. So, *extensibility at the module level* requirement was born out of this observation.

Finally, ability to visualize the same data in multiple ways is extremely important from an understanding perspective. For example, one may want to visualize Covid cases/deaths/hospitalizations as a temporally animated graph for different states. One

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18:59

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Results



• Communicates study outcomes, answers research questions and supports or refutes hypotheses.

• Presenting Data (Tables, Figures)

• Interpreting Results

- Connection to Research Questions:
 - Clearly links results to specific questions.
- Comparison with Hypotheses:
 - Assesses support or contradiction of hypotheses.
- Discussion of Patterns and Trends:
 - Identifies and discusses data patterns.
- Acknowledgment of Limitations:
 - Addresses study limitations or unexpected outcomes.

Results
The results of the study provide insight into the effectiveness of the mindfulness intervention in reducing stress levels among college students.

1. Descriptive Statistics:
Table 1 displays descriptive statistics for stress levels measured by the Perceived Stress Scale (PSS) in both the intervention and control groups. Mean stress scores at the beginning of the study were comparable between the groups (Intervention group $M = 18.2$, $SD = 3.5$; Control group $M = 18.0$, $SD = 3.2$).

2. Intervention Effectiveness:
Figure 1 illustrates the change in stress levels over the 8-week intervention period. The intervention group shows a noticeable decrease in stress scores ($M = 12.6$, $SD = 2.8$) compared to the control group ($M = 17.8$, $SD = 3.4$) at the post-intervention assessment.

3. Statistical Analysis:
A paired-sample t-test comparing pre- and post-intervention stress scores within the intervention group reveals a significant reduction in stress levels ($t(49) = 9.14$, $p < 0.001$). Additionally, an independent sample t-test comparing post-intervention scores between the intervention and control groups demonstrates a significant difference ($t(98) = 5.32$, $p < 0.001$), indicating the effectiveness of the mindfulness intervention.

4. Patterns and Trends:
While the intervention group exhibited a consistent decrease in stress levels, individual differences were observed. Participants who actively engaged in daily mindfulness practice showed more substantial reductions in stress compared to those with lower adherence.

5. Limitations:
It is important to acknowledge limitations, including self-report bias in stress assessment and potential variability in engagement with mindfulness practices. Additionally, the study's short duration may not capture long-term effects.

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19:02

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Effective Research Paper Presentations



- Importance of Clear Communication:
 - It ensures that the audience comprehends the significance of the study, its methodology, and the obtained results

- Tips for Effective Presentations:

- Practice and Timing
- Visual Aids
- Engaging the Audience
- Handling Questions

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13



Methodology

- It is systematic approach to execute and replicate the study.
- Components
 1. Research Design: Specifies the overall plan (experimental, correlational, qualitative).
 2. Participants: Describes characteristics and inclusion/exclusion criteria.
 3. Materials: Lists tools, instruments, or materials used for data collection.
 4. Procedure: Outlines step-by-step process from recruitment to analysis.
- Rigor and Reproducibility
 - Rigor ensures accuracy; reproducibility validates and generalizes findings.

Literature Review



- It is critical examination of existing scholarship relevant to the research topic
- Components
 - Scope: defines review boundaries.
 - Relevant studies: summarize existing research.
 - Gaps: highlight shortcomings, set stage for contribution.
- Tips for Writing an Effective Literature Review
 - Thematic organization.
 - Critical analysis of studies.
 - Synthesis of findings.
 - Clarity and conciseness.
 - Integration with research objectives.

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Evaluating and Example



"Energizing Tomorrow: Exploring the Potential of Advanced Battery Technologies for Sustainable Energy Storage"

Introduction: Welcome to an exploration of the intricate realm of sustainable energy and the critical need for advanced battery technologies. In a world grappling with escalating energy demands, the backdrop of this study is set against the pressing challenge of efficient energy storage. As we embark on this research journey, the components of the introduction—the background, problem statement, research questions, and objectives—will collectively illuminate the path toward understanding and addressing this contemporary issue.

Background: The canvas of sustainable energy unfolds against a backdrop of global energy dynamics. Existing knowledge underscores the urgency of developing cost-effective and environmentally friendly storage methods. Trends in energy consumption and emerging technologies shape the context for our inquiry into advanced battery technologies.

Problem Statement: Amidst the advancements in renewable energy, a distinct gap looms—the need for efficient energy storage solutions. Current technologies fall short in providing scalable, sustainable, and economically viable options. This problem statement establishes the research's relevance in a world increasingly reliant on clean and reliable energy sources.

Research Questions/Hypotheses: To navigate this uncharted territory, our inquiry is guided by fundamental questions. How can advanced battery technologies revolutionize energy storage? What are the key challenges in their widespread adoption? These research questions lay the foundation for our exploration and set the tone for hypothesis formulation.

Objectives: Within this tapestry, the study unfolds with clear objectives. Firstly, to assess the potential of advanced battery technologies in transforming energy storage. Secondly, to identify and address challenges hindering their large-scale implementation. These objectives define our goals, providing direction and purpose to the research endeavour.

As we venture into the intricacies of sustainable energy and advanced battery technologies, the introduction serves not only to orientate but to underscore the significance of our quest. The background establishes the context, the problem statement sharpens our focus, research questions guide our inquiry, and objectives chart the course for a meaningful exploration into the future of energy storage.

1. Comprehensive Contextualization:

- Establishes a rich context for sustainable energy, integrating trends and global dynamics.

2. Clearly Defined Problem Statement:

- Articulates a precise gap, emphasizing the urgency and relevance of energy storage.

3. Focused Research Questions:

- Crafted questions guide the study, framing the investigation and providing a roadmap.

4. Purposeful Objectives:

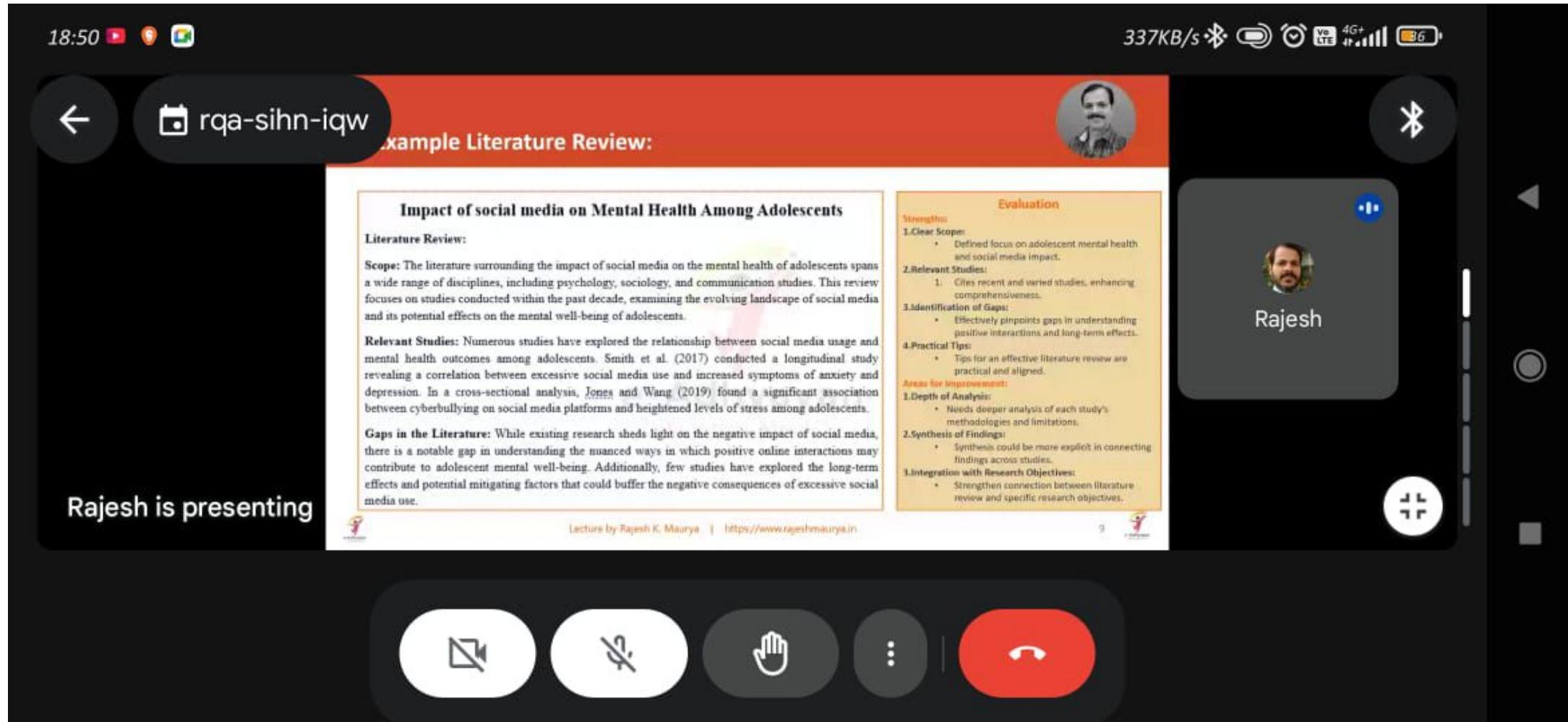
- Specific and aligned goals provide direction, contributing to the overall research goal.

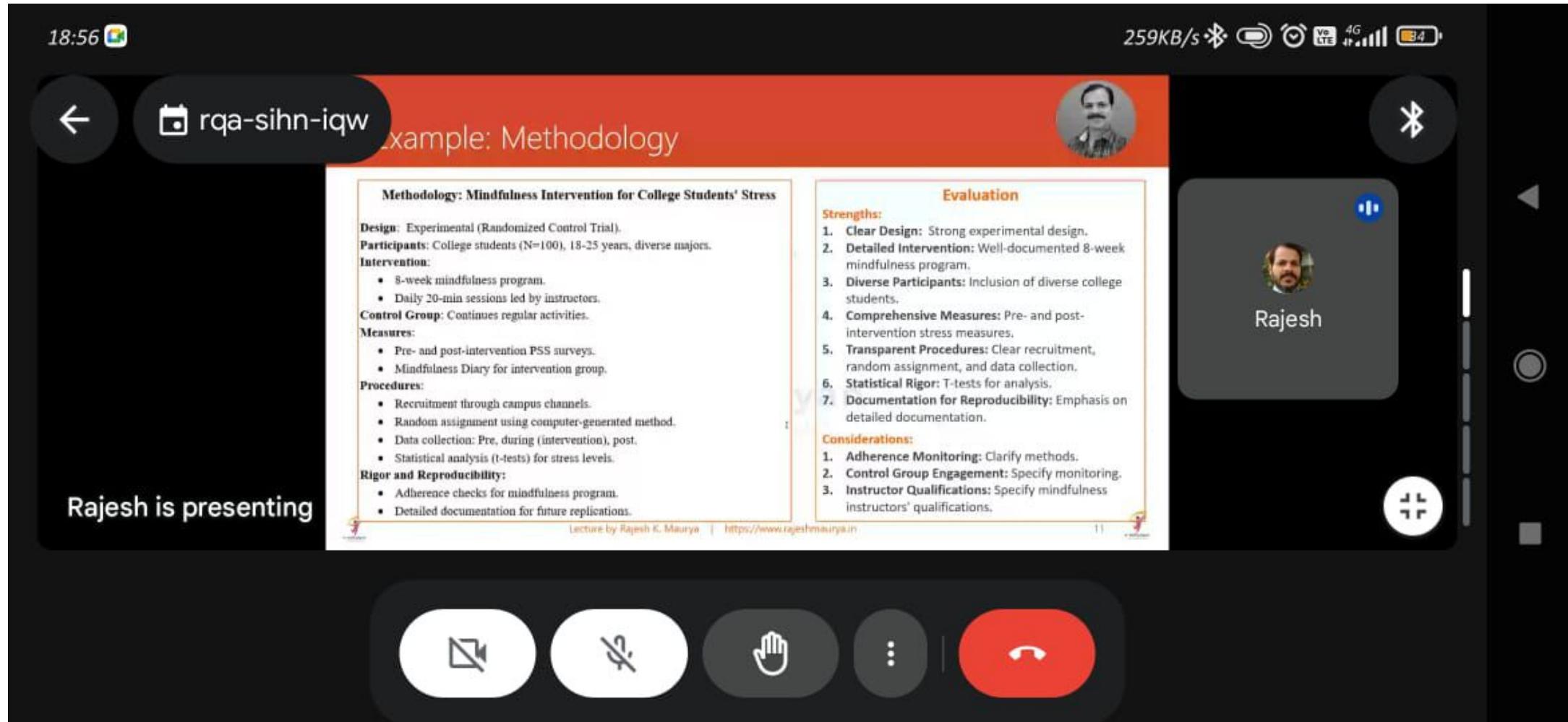
5. Engaging Title:

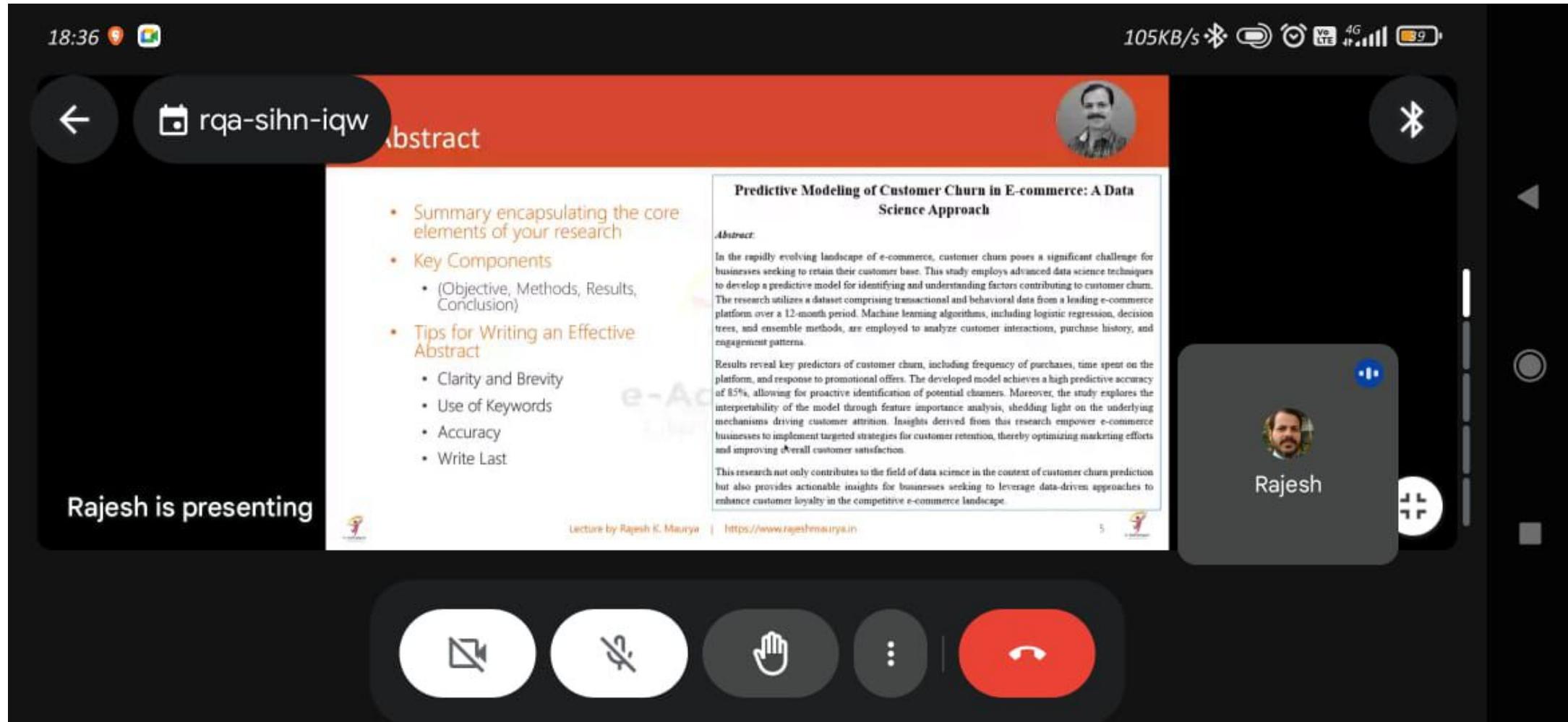
- The title, "Energizing Tomorrow," captures the essence and sparks interest in potential outcomes.



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Structure of a Research Paper



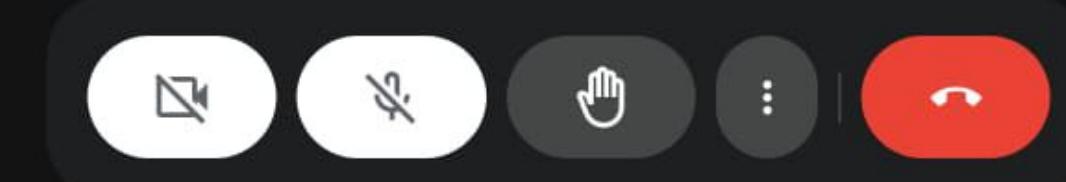
- **Title and Authors:**
 - Concise, informative title; acknowledges all contributing authors.
- **Abstract:**
 - Brief summary highlighting objectives, methods, results, and conclusions.
- **Introduction:**
 - Sets stage, introduces problem, outlines study objectives.
- **Literature Review:**
 - Contextualizes research, identifies gaps, synthesizes relevant studies.
- **Methodology:**
 - Details research design, participants, materials, ensures rigor.
- **Results:**
 - Presents findings objectively using tables, figures, statistics.
- **Discussion:**
 - Interprets results, explores implications, relates findings to literature.
- **Conclusion:**
 - Summarizes key findings, discusses implications, suggests future research.
- **References:**
 - Acknowledges sources, demonstrates academic integrity, guides further exploration.

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Introduction



- It Guides, Establishes Relevance, Frames Research, Academic or Practical Significance
- Components
 - Background:
 - Contextualization, Trends, Existing Knowledge, Setting
 - Problem Statement:
 - Specific Issue, Relevance, Urgency, Framing
 - Research Questions/Hypotheses:
 - Guiding Inquiries, Hypothesis Formulation, Roadmap
 - Objectives:
 - Specific Goals, Outcomes, Direction, Alignment
 - Examples

Example:

"With the advent of artificial intelligence in healthcare, this research investigates the ethical implications of using predictive algorithms in patient diagnosis. As technology continues to reshape medical practices, understanding the ethical considerations is paramount to ensuring responsible and unbiased use of AI in the healthcare domain."



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