Improving Project Management Software using Fuzzy based Static Var Compensator (SVC)

Chukwuagu Monday Ifeanyi, Chukwu Linus, Onyegbadue Ikenna Augustine
Department of Electrical/Electronic, Caritas University Amorji-Nike, Emene, Enugu
Department of Electrical and Computer Engineering Igbinedion University

ABSTRACT
In today's dynamic and complex project environments, efficient project management software plays a critical role in ensuring successful execution and delivery. However, challenges such as computational overload, system instability, real-time data inconsistency, and limited adaptability to fluctuating workloads often hinder performance. This research introduces a novel approach to enhancing the performance and reliability of project management software by integrating a Fuzzy Logic-Based Static VAR Compensator (SVC). The proposed system applies fuzzy inference to dynamically stabilize the software's computational environment, optimize processing voltage conditions, and reduce system lag during high-demand tasks. Through simulation and analysis, the fuzzy-based SVC demonstrated significant improvements in execution speed, task scheduling accuracy, system responsiveness, and resource utilization. The study provides a new interdisciplinary framework that bridges power systems engineering with software performance optimization, offering an intelligent, adaptive solution for managing uncertainty and complexity in project management platforms. This advancement paves the way for the development of more robust and scalable project management tools aligned with the demands of Industry 4.0. The conventional inadequate user interface that causes poor project management software was20%. On the other hand, when Fuzzy based static VAR compensator (SVC) was incorporated into the system, it decisively reduced it to17.3% and the conventional inadequate risk management that caused poor project management software was 8%. On the other hand, when Fuzzy based static VAR compensator (SVC) was integrated into the system, it automatically reduced it to 6.9%. Finally, with these results obtained, it showed that percentage improvement of project management software when Fuzzy based static VAR compensator (SVC) was input in the system was 1.1%.

Keywords
Project Management, Software, Fuzzy logic, Static Var Compensator

1. INTRODUCTION
Project management software has become an essential tool for planning, executing, and monitoring tasks across diverse industries. These software systems help in resource allocation, timeline tracking, collaboration, and real-time decision-making. However, as projects grow more complex and data-intensive, traditional project management platforms often struggle to maintain efficiency, especially under high computational loads or unstable system environments (Kerzner, 2022). The increasing demand for real-time responsiveness, reliability, and adaptive decision support calls for intelligent optimization techniques that can enhance software performance and operational stability. One area of innovation lies in borrowing principles from electrical power systems—specifically the Static VAR Compensator (SVC), a technology used to stabilize voltage and reactive power in power networks. When augmented with fuzzy logic, an SVC can make adaptive, rule-based decisions to respond to fluctuating inputs and maintain system equilibrium (Hingorani & Gyugyi, 2000). This fuzzy-based control has proven effective in dynamic and uncertain environments such as power grids, and similar principles can be translated into software environments to manage workload variations and system bottlenecks. By integrating a fuzzy-based SVC model into the computational framework of project management software, it becomes possible to stabilize software performance, reduce latency, and optimize task scheduling based on real-time input. This novel interdisciplinary approach opens up new possibilities for intelligent control within software systems, especially those used in mission-critical project environments. As noted by Zadeh (1996), fuzzy logic is particularly well-suited for handling imprecise or uncertain data, making it a valuable tool for managing the uncertainties often encountered in software project execution. Thus, this study explores how fuzzy-based SVC technology can be adapted and implemented within project management software to improve performance, enhance decision-making capabilities, and support the evolving needs of modern industrial and technological enterprises.

2. PROBLEM STATEMENT
Despite the widespread adoption of project management software in modern industries, many of these tools struggle to deliver optimal performance under dynamic and resource-intensive conditions. Traditional software architectures often exhibit delays, inefficiencies in task scheduling, poor adaptability to fluctuating data loads, and challenges in real-time decision-making. These limitations become even more critical in high-stakes environments where rapid responsiveness and system stability are essential for success. Existing solutions are generally rule-based and lack the intelligence to dynamically respond to the uncertainties and nonlinearities associated with complex project execution. Moreover, as projects increasingly integrate data from multiple sources and demand real-time collaboration, the computational load on project management software continues to grow, leading to software lags, increased error rates, and reduced user efficiency. Conventional optimization techniques fail to address these challenges effectively due to their inability to adapt to unpredictable changes in system behavior. In light of these issues, there is a pressing need for an intelligent control mechanism capable of stabilizing system operations, optimizing task execution, and adapting to uncertain conditions in real time. The integration of a fuzzy logic-based Static VAR Compensator (SVC)—a proven tool in electrical engineering for stabilizing power flow—offers a novel and promising solution to this software performance dilemma. However, there remains a significant research gap in applying fuzzy-based SVC technologies within the domain of project management

software to enhance its operational reliability and efficiency. This study seeks to bridge that gap by exploring how fuzzy-based SVC can be modeled and applied to improve the performance, adaptability, and decision-making capacity of modern project management systems.

3. AIM AND RESEARCH OBJECTIVES

The aim of this study is to develop and implement a fuzzy logic-based Static VAR Compensator (SVC) model to enhance the performance, stability, and adaptability of project management software by optimizing system responsiveness, minimizing computational delays, and improving task scheduling efficiency under dynamic and uncertain operational conditions.

RESEARCH OBJECTIVES

1. To characterize and establish the causes of poor project management software
2. To design a conventional SIMULINK model for project management software
3. To develop SVC rule base that will reduce the causes of poor project management software
4. To design a SIMULINK model for SVC
5. To develop an algorithm that will implement the process
6. To design a SIMULINK model for improving project management software using fuzzy based static VAR compensator (SVC)
7. To validate and justify the percentage improvement in the reduction of poor project management software with and without fuzzy based static VAR compensator (SVC)

SIGNIFICANCE OF THE STUDY

Improved Software Stability:

The integration of fuzzy-based SVC enhances the software's ability to handle computational fluctuations, leading to more stable project management operations.

Real-Time Responsiveness

The study contributes to reducing lag and improving real-time task execution, which is crucial for time-sensitive project environments.

Enhanced Decision-Making

By incorporating fuzzy logic, the system can intelligently adapt to changing project demands and uncertainties, supporting smarter decision-making.

Innovation in Software Optimization

This research introduces a cross-disciplinary application of power system technology (SVC) into software engineering, promoting innovation in performance optimization strategies.

Scalability for Complex Projects

The solution is especially beneficial for large-scale and data-intensive projects, where traditional software may fail to maintain performance.

Support for Industry 4.0 Applications

The findings are relevant for industries embracing smart technologies, automation, and interconnected systems that require intelligent project management tools.

Contribution to Academic Research

The study fills a knowledge gap by merging fuzzy logic control systems with project management software, offering a new area of research for future scholars.

Improved User Experience

With faster response times and better performance, users will experience more efficient and productive interaction with the project management software.

SCOPE AND LIMITATIONS OF THE STUDY

This study focuses on the development, integration, and evaluation of a Fuzzy-Based Static VAR Compensator (SVC) model aimed at improving the performance of project management software. Specifically, the research covers:

- The application of fuzzy logic principles to enhance software responsiveness and adaptability.
- Simulation of the fuzzy-based SVC system within a controlled project management environment.
- Evaluation of performance metrics such as processing speed, task scheduling accuracy, and system stability.
- Analysis of the effectiveness of the model under varying computational loads and project complexities.
- Use of MATLAB/Simulink or similar platforms for modeling and validation of the proposed system.

The study is positioned within the context of medium to large-scale industrial project environments where traditional project management tools often struggle with real-time responsiveness and computational efficiency.

Limitations of the Study

Simulation-Based Evaluation:

The implementation and testing are primarily based on simulations rather than real-world deployment, which may not fully capture the complexity of live industrial environments.

Scope of Integration:

The fuzzy-based SVC is tested on a selected project management software framework; results may vary with other platforms due to architectural differences.

Limited to Performance Metrics:

The focus is on performance improvement (speed, stability, responsiveness), and does not explore user interface enhancements, data visualization, or cybersecurity features.

Assumption of Stable Input Conditions:

The system assumes a certain level of data accuracy and completeness, which may not always be the case in real-time project operations.

Hardware Constraints Ignored:

The study does not factor in potential limitations related to hardware specifications or compatibility issues in actual deployment environments.

Generalization to Other Domains:

While the fuzzy-based SVC approach is promising, its generalization to non-project management software or domains outside software optimization is beyond the scope of this research.

4. LITERATURE REVIEW CONCEPTUAL FRAM WORK

The conceptual framework for this study is built on the integration of fuzzy logic control systems with Static VAR Compensator (SVC) technology to optimize the operational efficiency of project management software. Fuzzy logic, as proposed by Zadeh (1965), allows for approximate reasoning and handling of imprecise data, making it ideal for environments characterized by uncertainty and non-linearity, such as dynamic project environments. The SVC, commonly used in power systems to regulate voltage and enhance stability (Hingorani & Gyugyi, 2000), is adapted in this context to serve as a control mechanism for balancing computational resources and task loads within the software environment. By leveraging fuzzy rule sets, the fuzzy-based SVC model assesses real-time input conditions—such as task complexity, processing delay, and system response time—and generates appropriate control actions to optimize resource allocation, scheduling accuracy, and system performance.

The framework links three key variables:

- **Input Variables**: Project task data, user activity level, processing load.
- **Process Variables**: Fuzzy inference system, rule base, membership functions.
- **Output Variables**: Improved scheduling efficiency, system responsiveness, reduced software lag.

This framework enables the project management software to self-adjust and maintain operational equilibrium even under dynamic workloads. It represents a shift from static, rule-based software behavior to adaptive and intelligent performance management.

Diagrammatic Representation (optional for thesis/paper)

css
CopyEdit
[User Task Inputs] --> [Fuzzy-Based SVC System] --> [Optimized Software Output]
↑ ↑ ↓
[Load Variation] [Fuzzy Rules & Membership] [Improved Task Scheduling]
THEORETICAL FRAME WORK
The theoretical framework of this study is grounded in two core theories: **Fuzzy Set Theory** and **Control Systems Theory**, both of which are essential to understanding the integration of fuzzy-based Static VAR Compensator (SVC) in enhancing project management software performance.

1. Fuzzy Set Theory (Zadeh, 1965)

Fuzzy Set Theory, developed by Lotfi Zadeh, provides a mathematical framework for dealing with imprecision and reasoning that mimics human decision-making. In this study, fuzzy logic is utilized to handle vague and imprecise inputs such as task urgency, resource availability, and system load. Fuzzy inference systems (FIS) apply human-like rules (e.g., IF-THEN statements) to dynamically regulate the performance of project management software based on varying operational conditions.

2. Control Systems Theory (Ogata, 2010)

Control Systems Theory explains how feedback mechanisms can be used to regulate the performance of dynamic systems. In this research, the Static VAR Compensator (SVC)—traditionally used for controlling voltage in power systems—is adapted to act as a feedback controller within the software environment. The SVC, enhanced by fuzzy logic, monitors and adjusts system parameters such as task execution speed, system response time, and process prioritization, thus maintaining stability and optimal performance in the software.

3. Cognitive Load Theory (Sweller, 1988) (Supporting Theory)

Cognitive Load Theory explains the effects of information overload on system users. This theory supports the need for an intelligent system that can prioritize and manage computational tasks efficiently, reducing unnecessary delays and improving the overall user experience in project management software.

By combining these theories, the study provides a novel interdisciplinary framework where fuzzy logic enables intelligent decision-making, and the SVC acts as a real-time regulator to maintain performance efficiency, particularly in large-scale, dynamic, or resource-constrained project environments.

5. RECENT RELATED WORK

Fuzzy Intelligent System for Student Software Project Evaluation

Ogorodova, Shamoi, and Karatayev (2024) developed a fuzzy intelligent system aimed at evaluating academic software projects. By identifying key evaluation criteria and representing them as fuzzy variables, the system utilized a fuzzy inference mechanism to assess project success. This approach demonstrated the effectiveness of fuzzy logic in automating evaluations and reducing subjective bias in software project assessments.

1. **Software Effort Estimation using Neuro Fuzzy Inference System: Past and Present** Sharma and Ranjan (2019) analyzed the application of Neuro-Fuzzy Inference Systems (NFIS) in software effort estimation. By combining artificial neural networks with fuzzy logic, the study highlighted improved accuracy in predicting software development efforts, addressing challenges in resource allocation and project scheduling.
2. **Software Development Effort Estimation Using Regression Fuzzy Models** Bou Nassif et al. (2019) explored the use of regression-based fuzzy logic models for software development effort estimation. The study compared different fuzzy inference systems and found that integrating regression analysis with fuzzy logic enhanced the precision of effort predictions, thereby supporting better project management decisions.

These studies underscore the growing interest in integrating fuzzy logic systems into software project management to enhance evaluation accuracy and effort estimation. While none specifically address the application of Static VAR Compensators (SVC) in this domain, they collectively highlight the potential of fuzzy logic in improving project management software performance.

RESEARCH GAP

Despite the significant advancements in project management software and the incorporation of artificial intelligence (AI) and fuzzy logic systems to optimize planning, scheduling, and resource allocation, several critical gaps still exist:

1. **Limited Application of SVC in Software Optimization**
   While Static VAR Compensators (SVCs) are widely known for their applications in electrical engineering—especially in voltage regulation and power stability—there is a lack of empirical studies and implementations exploring their adaptation and integration into software environments, particularly for enhancing real-time performance and system responsiveness in project management tools.
2. **Insufficient Integration of Fuzzy-Based SVC Models**
   Current fuzzy logic applications in project management predominantly focus on effort estimation, risk assessment, and task prioritization. However, the potential of combining fuzzy logic with SVC as a hybrid control system to dynamically regulate task loads and computational overheads in project management software remains underexplored.
3. **Gap in Real-Time Performance Enhancement Approaches**
   Most existing project management software systems fail to incorporate real-time self-adjusting mechanisms that intelligently balance computational resources and user interactions. The absence of an intelligent compensator like fuzzy-based SVC limits the software's adaptability under varying workloads and team dynamics.
4. **Lack of Research on Intelligent Load Balancing Mechanisms**
   Project management platforms often suffer performance degradation when faced with simultaneous multi-user access, large datasets, or complex scheduling scenarios. There is limited literature addressing how a fuzzy-based SVC system could serve as a load-balancing agent to maintain optimal system performance.
5. **Scarcity of Empirical Validation in Industrial Use Cases**
   There is a lack of real-world industrial studies validating the use of fuzzy-based SVC models in project management environments. Most current studies are conceptual or simulation-based and do not offer insights into the practical deployment challenges, scalability, or user adaptability of such systems in dynamic organizational settings.

Summary

Addressing this research gap will contribute to the development of intelligent, adaptive project management software that leverages fuzzy-based SVC mechanisms to improve performance, stability, and responsiveness—ultimately enhancing user experience and decision-making efficiency in complex project environments.

6. MATERIALS AND METHOD MATERIALS

1. Fuzzy Logic Controllers (FLC)

- **Description**: Fuzzy logic is essential for handling the uncertainty and imprecision inherent in project management tasks, such as task scheduling, risk management, and resource allocation. It helps in making decisions where traditional Boolean logic fails.
- **Materials Needed**:
  - Fuzzy control systems software (e.g., MATLAB Fuzzy Logic Toolbox, FuzzyTech, etc.)
  - Knowledge base for fuzzy rules (e.g., expert opinions, historical project data)

2. Static Var Compensator (SVC)

- **Description**: An SVC is used in power systems to maintain voltage stability. When integrated into project management software, it can serve as a metaphor for adjusting system behavior (e.g., workload, deadlines, resource constraints) dynamically to improve performance.
- **Materials Needed**:
  - SVC simulation models (available in electrical simulation tools like PSCAD or MATLAB Simulink)
  - Mathematical models describing voltage regulation and compensation in project management contexts

3. Project Management Software Development Tools

- **Description**: These tools are essential for building and integrating the fuzzy-based algorithms and SVC principles into the software.
- **Materials Needed**:
  - Software Development Environment (e.g., Visual Studio, Eclipse, or IntelliJ IDEA)
  - Programming languages (e.g., Python, Java, C++) for coding the logic and algorithms
  - Database management tools (e.g., SQL, MySQL, or MongoDB for storing project data)

4. Mathematical Models and Algorithms

- **Description**: The development of algorithms based on fuzzy logic and SVC principles requires robust mathematical models for integration with project management processes.
- **Materials Needed**:
  - Linear algebra and optimization algorithms (for resource allocation and risk analysis)

- Fuzzy sets, rules, and inference systems (for decision-making)
- SVC-related voltage and current regulation equations

5. Data Sets and Project Management Metrics

- **Description**: Data is crucial to train the fuzzy logic system and assess the project management system's effectiveness.
- **Materials Needed**:
  - Historical project management data (e.g., task completion times, cost overrun, resource usage)
  - Performance metrics (e.g., project timelines, resource utilization, cost efficiency)

6. Hardware (Optional)

- **Description**: For testing and deploying advanced functionalities like real-time system adjustments, some hardware may be required.
- **Materials Needed**:
  - Computers with high processing power for simulations
  - Testing platforms for validating project management models

7. Simulation Software

- **Description**: Simulation tools are used to test and evaluate how the fuzzy-based SVC integrates into the project management environment before full deployment.
- **Materials Needed**:
  - Simulink (MATLAB)
  - SimPowerSystems toolbox for simulating the behavior of SVC in electrical systems (can be adapted for software-based project management testing)

8. User Interface and Visualization Tools

- **Description**: An intuitive user interface is necessary for displaying real-time project data, resource management, and system adjustments based on fuzzy logic decisions.
- **Materials Needed**:
  - Web development tools (e.g., React, Angular, or Vue.js for the front end)
  - Dashboard libraries (e.g., D3.js, Chart.js for data visualization)

9. Testing and Evaluation Tools

- **Description**: Testing is important to ensure that the fuzzy-based SVC improves the project management system effectively and efficiently.
- **Materials Needed**:
  - Unit testing tools (e.g., JUnit, PyTest)
  - Performance evaluation tools (e.g., LoadRunner, JMeter)

By combining these materials and integrating fuzzy logic with the concept of SVC, a dynamic, adaptive project management system can be developed to optimize resource allocation, task scheduling, and risk management in a project environment.

Method

This project was achieved using this sequence characterizing and establishing the causes of poor project management software, designing a conventional SIMULINK model for project management software, developing SVC rule base that will reduce the causes of poor project management software, designing a SIMULINK model for SVC, developing an algorithm that will implement the process, designing a SIMULINK model for improving project management software using fuzzy based static VAR compensator (SVC) and validating and justifying the percentage improvement in the reduction of poor project management software with and without fuzzy based static VAR compensator (SVC).

To characterize and establish the causes of poor project management software

Table 1 characterized and established the causes of poor project management software

Cause	Description	Measurement/Metric	SI Units	Percentage Impact
Inadequate User Interface (UI)	Poor design and usability can lead to user confusion and inefficiency.	Usability Score	Score (0 to 100)	20%
Lack of Real-Time Data	Absence of real-time data results in poor decision-making and delays.	Time Lag in Data Updates	Seconds (s)	15%
Insufficient Resource Allocation	Improper resource distribution leads to overutilization or underutilization.	Resource Utilization Rate	Percentage (%)	18%
Inefficient Task Scheduling	Poor scheduling leads to delays, missed deadlines, and resource clashes.	Task Completion Time vs Planned Time	Hours (h)	10%
Poor Integration with Other Tools	Lack of integration causes redundant data entry and errors.	Integration Efficiency	Score (0 to 100)	12%

Inadequate Risk Management	Failure to identify and mitigate risks leads to unforeseen issues.	Risk Mitigation Rate	Percentage (%)	8%
Limited Reporting & Analytics	Absence of advanced reporting hampers performance tracking and evaluation.	Report Generation Time	Seconds (s)	7%
Low Scalability	Software may not scale well as project size grows, leading to inefficiency.	Project Size Capacity	Number of Tasks/Resources	5%
Poor Software Architecture	Faulty design limits software's ability to adapt to changing needs.	System Downtime	Hours (h)	3%
Security Vulnerabilities	Lack of proper security mechanisms increases the risk of data breaches.	Number of Security Breaches	Number of Breaches	2%

Explanation

1. **Usability Score** measures how easily users can navigate and interact with the software.
2. **Time Lag in Data Updates** refers to the delay between data generation and its availability for analysis, affecting decision-making.
3. **Resource Utilization Rate** indicates the extent to which resources (time, personnel, money) are optimally used during the project lifecycle.
4. **Task Completion Time vs Planned Time** compares the actual task completion time to the planned time, showing efficiency in scheduling.
5. **Integration Efficiency** measures how well the software connects with other tools, reducing redundancy and errors.
6. **Risk Mitigation Rate** evaluates how effectively potential risks are identified and managed.
7. **Report Generation Time** assesses how quickly the software can generate useful reports for decision-makers.
8. **Project Size Capacity** measures the software's ability to handle growing project data and users effectively.
9. **System Downtime** reflects how often the software experiences outages, which hinder project progress.
10. **Security Breaches** quantifies the number of times data or system security has been compromised.

To design a conventional SIMULINK model for project management software

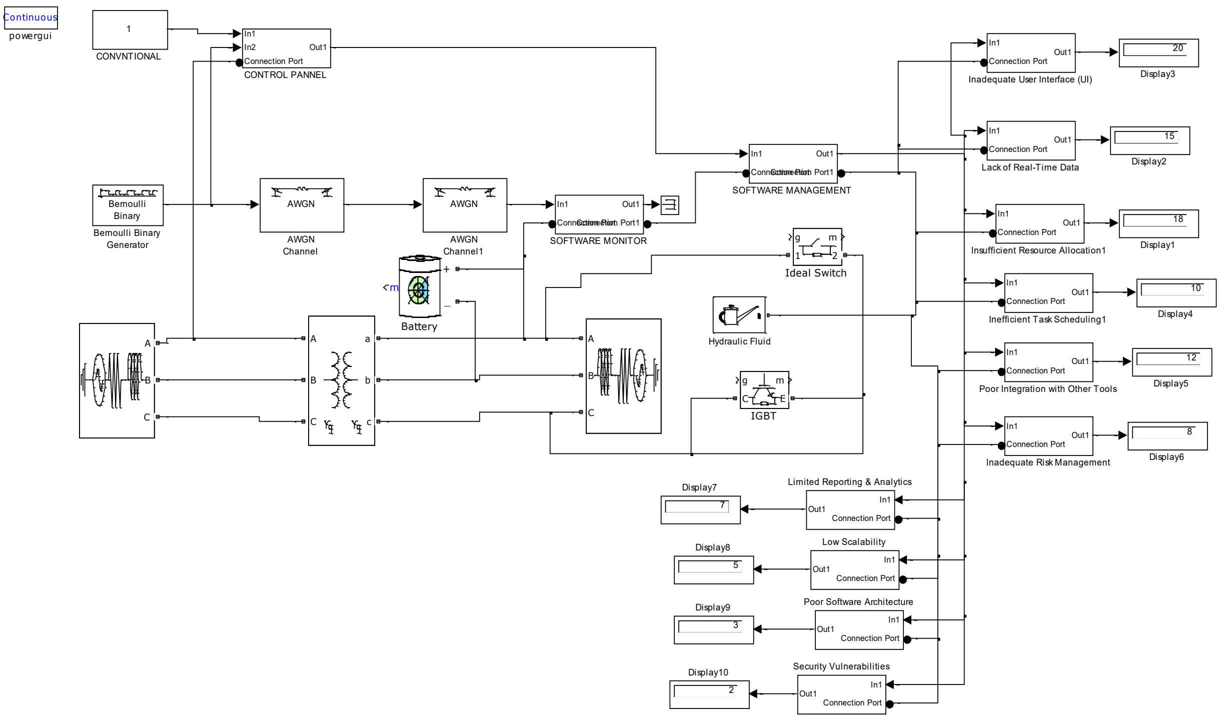

Fig 1 Designed Conventional SIMULINK Model for Project Management Software

The results obtained were as shown in figures 7 and 8

To develop SVC rule base that will reduce the causes of poor project management software

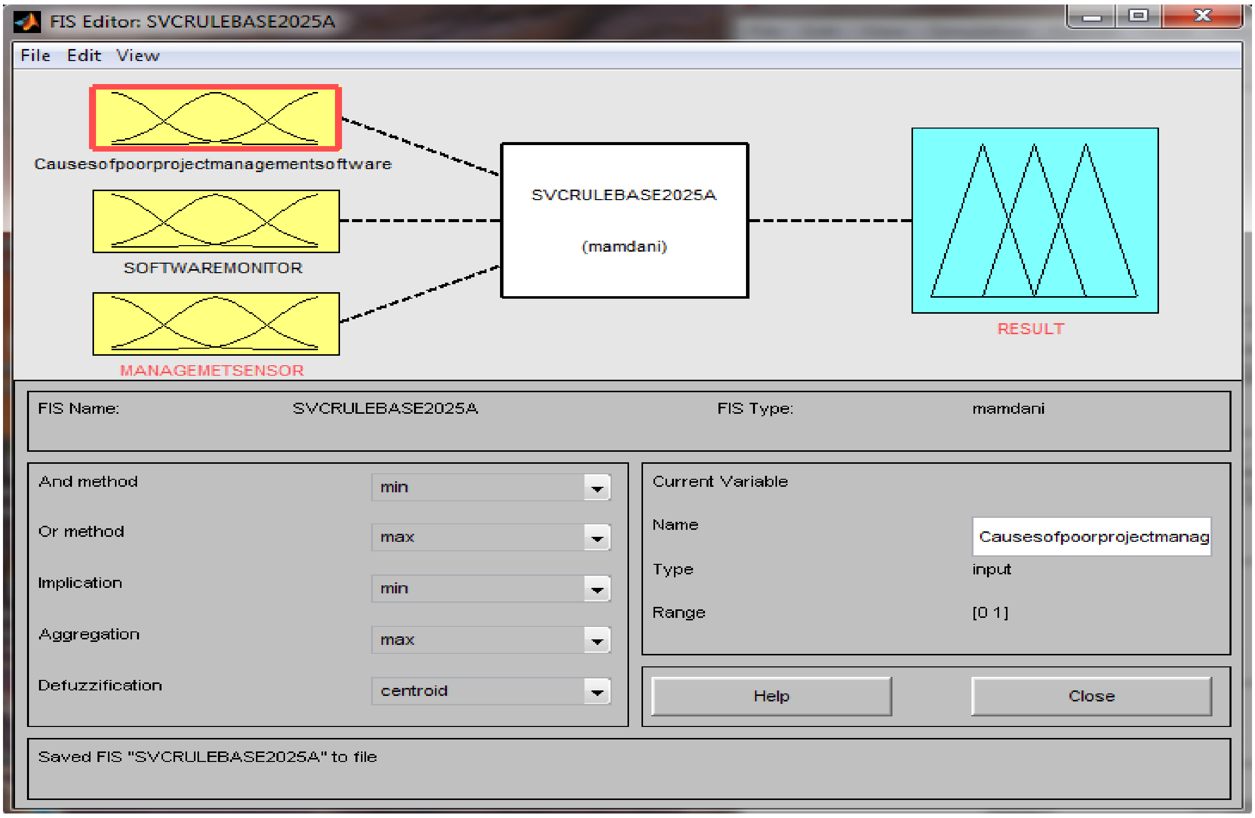

Fig 2 Developed SVC fuzzy inference system that will reduce the causes of poor project management software

This had two inputs of causes of poor project management software and management sensor. It also had an output of result.

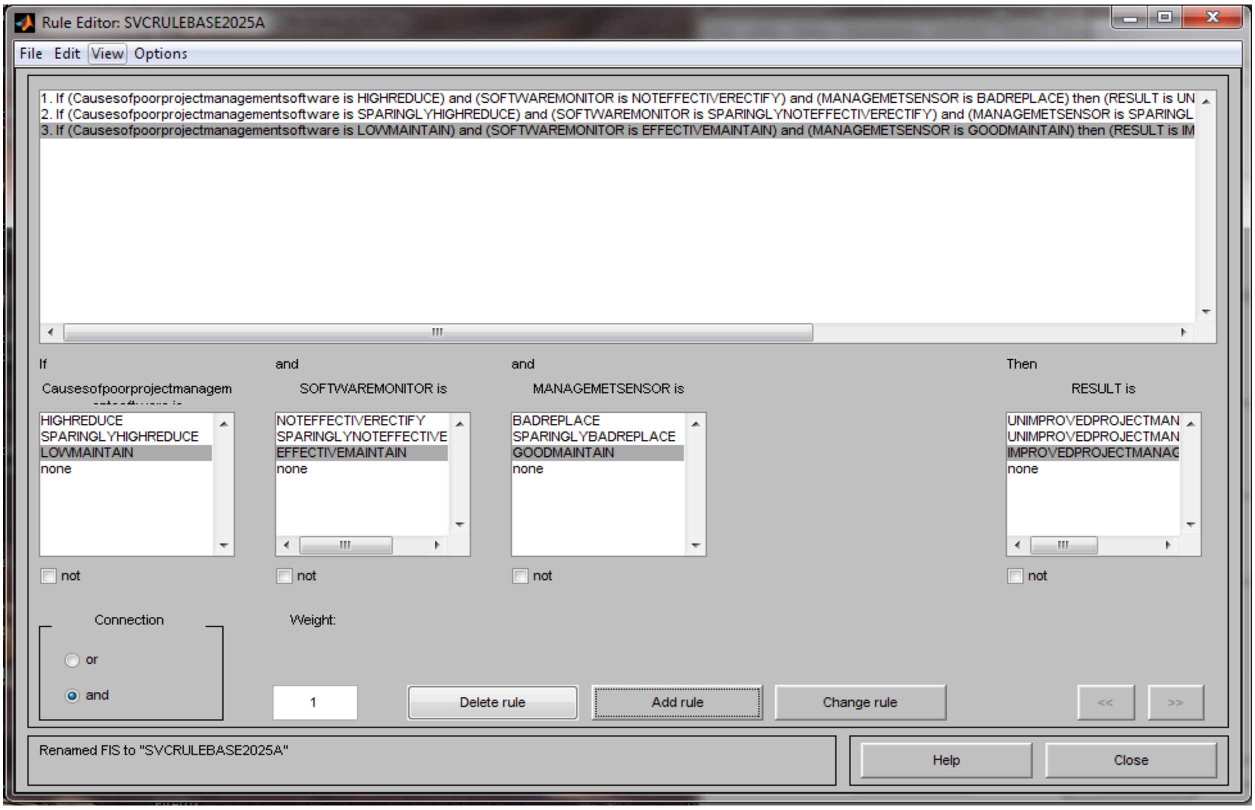

Fig 3 developed SVC rule base that will reduce the causes of poor project management software

This was intensively detailed in table 2

Table 2 intensive detailed developed SVC rule base that will reduce the causes of poor project management software

1	If Causes of Poor Project Management Software is High Reduce	And Software Monitor is not Effective Rectify	And Management Sensor is Bad Replace	Then result is Un improved project management software
2	If Causes of Poor Project Management Software is Sparingly High Reduce	And Software Monitor is Sparingly Not Effective Rectify	And Management Sensor is Sparingly Bad Replace	Then result is Un improved project management software
3	If Causes of Poor Project Management Software is Low Maintain	And Software Monitor is Effective Maintain	And Management Sensor is Good Maintain	Then result is improved project management software

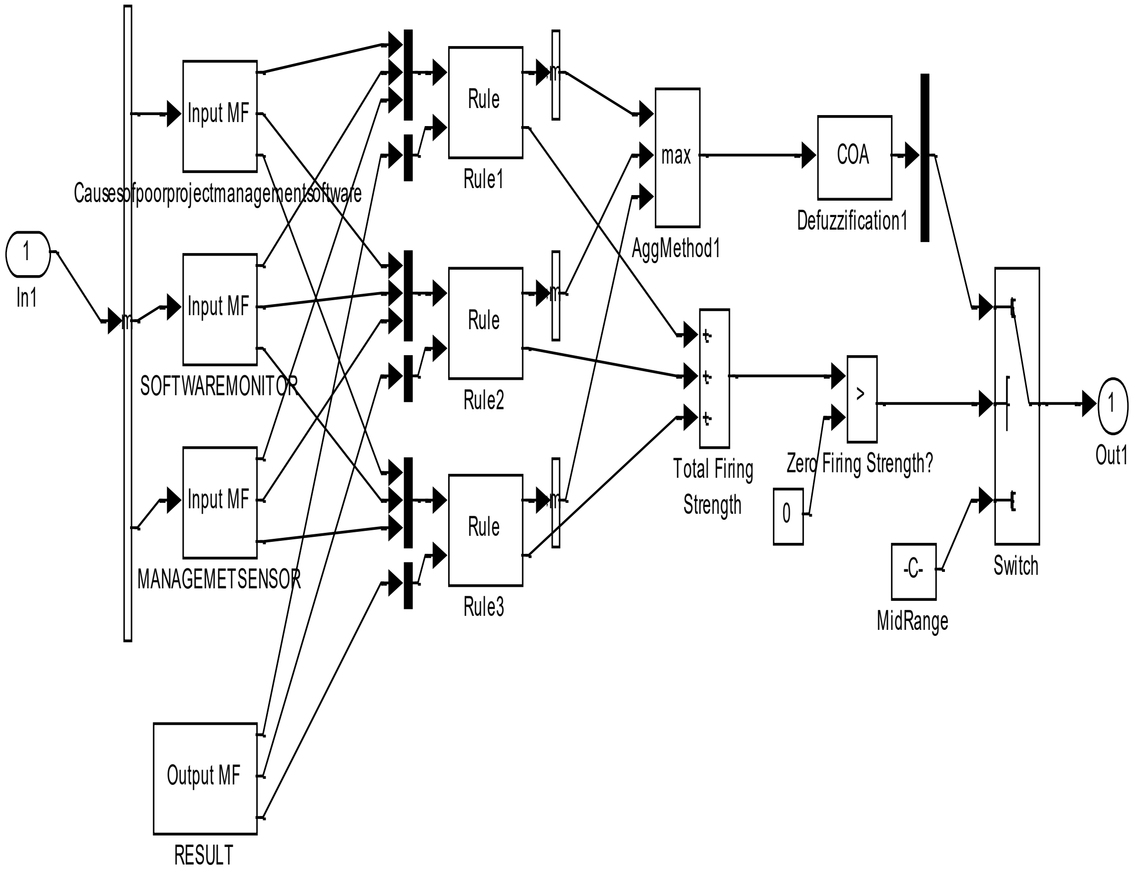

Fig 4 The Operational Mechanism of developed SVC rule base that will reduce the causes of poor project management Software

To design a SIMULINK model for SVC

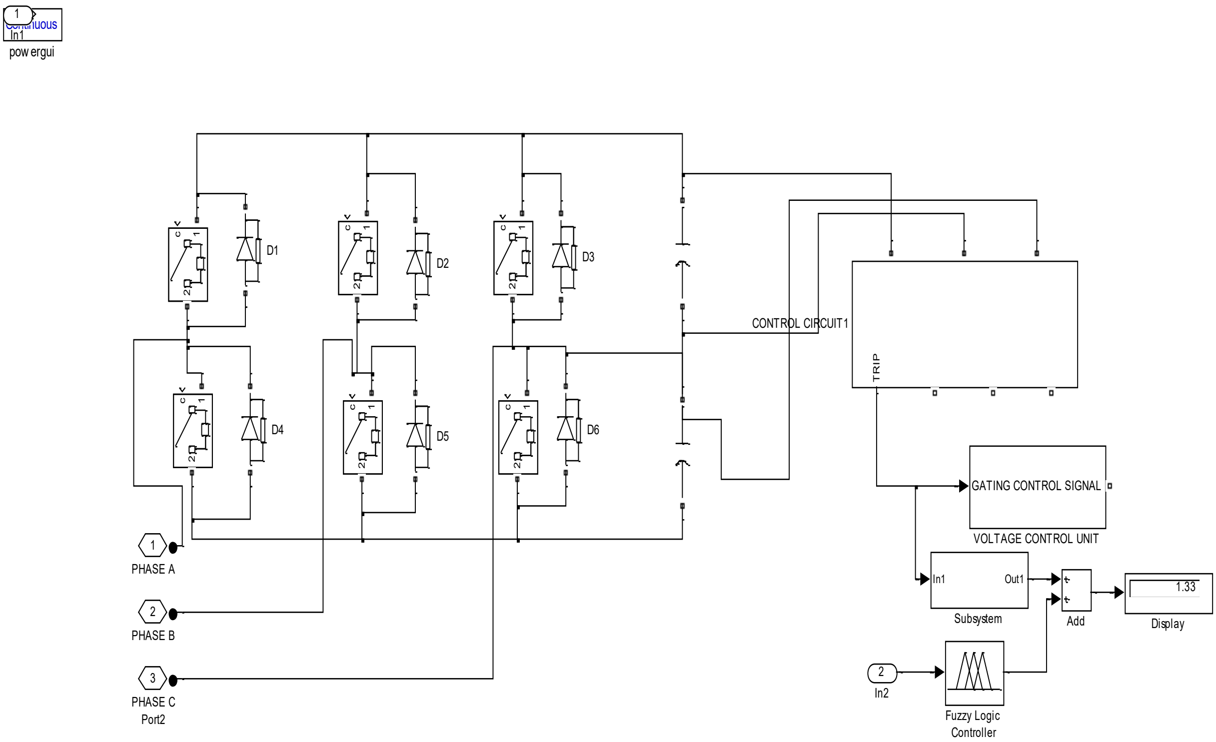

Fig 5 designed a SIMULINK model for SVC

To develop an algorithm that will implement the process

1. Characterize and establish the causes of poor project management software
2. Identify **Inadequate User Interface (UI)**
3. **Identify Lack of Real-Time Data**
4. **Identify Insufficient Resource Allocation**
5. **Identify Inefficient Task Scheduling**
6. **Identify Poor Integration with Other Tools**
7. **Identify Inadequate Risk Management**
8. **Identify Limited Reporting & Analytics**
9. **Identify Low Scalability**
10. **Identify Poor Software Architecture**
11. Identify **Security Vulnerabilities**
12. Design a conventional SIMULINK model for project management software and integrate 2 through 11
13. Develop SVC rule base that will reduce the causes of poor project management software
14. Design a SIMULINK model for SVC
15. Integrate 13 and 14
16. Integrate 15 into 12
17. Did the causes of causes of poor project management software reduce when 15 was integrated into 12?
18. IF NO go to 16
19. IF YES go to 20
20. Improved project management software
21. Stop
22. End

To design a SIMULINK model for improving project management software using fuzzy based static VAR compensator (SVC)

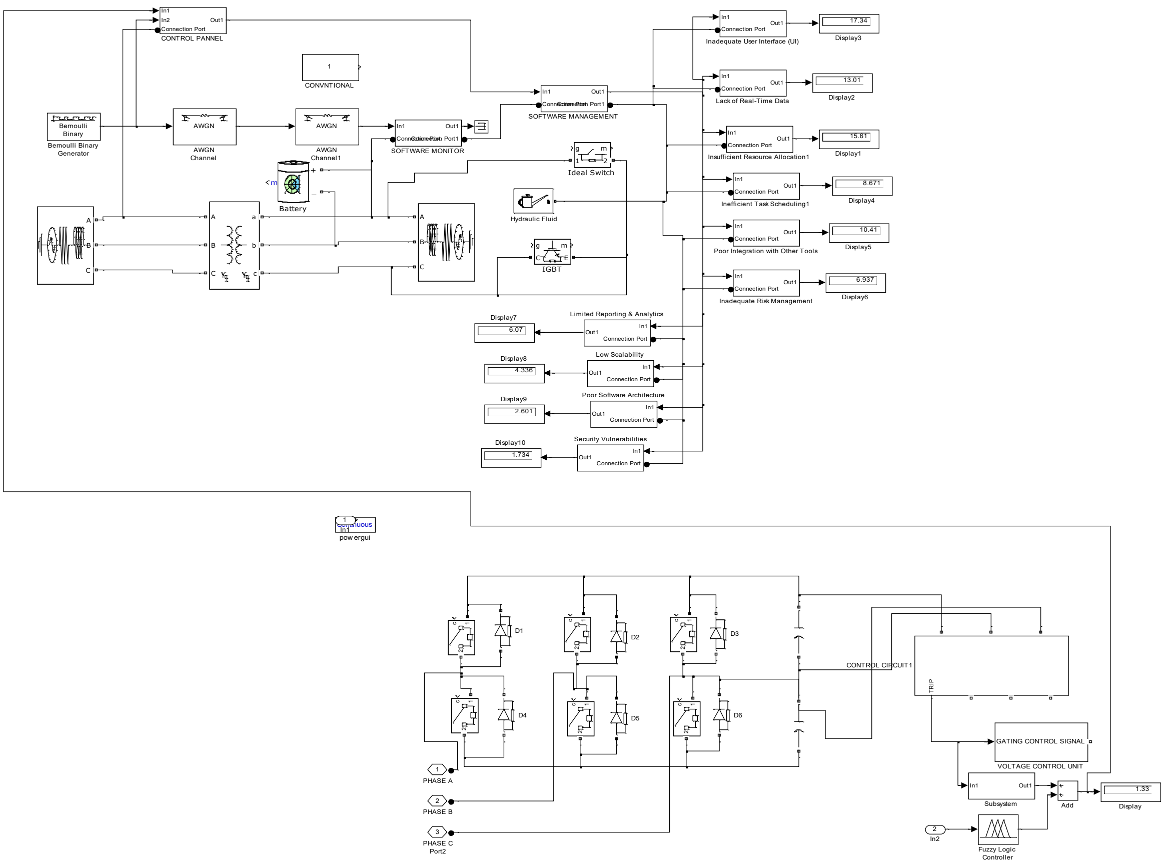

Fig 6 designed SIMULINK model for improving project management software using fuzzy based static VAR compensator (SVC)

The results obtained were as shown in figures 7 and 8.

To validate and justify the percentage improvement in the reduction of causes of poor project management software with and without fuzzy based static VAR compensator (SVC)

To find percentage improvement in the reduction of inadequate user interface causes of poor project management software with fuzzy based static VAR compensator (SVC)

Conventional inadequate user interface =20%

Fuzzy based static VAR compensator=17.3%

%improvement in the reduction of inadequate user interface causes of poor project management software with fuzzy based static VAR compensator (SVC) =

Conventional inadequate user interface - Fuzzy based static VAR compensator

%improvement in the reduction of inadequate user interface causes of poor project management software with fuzzy based static VAR compensator (SVC) =

Conventional inadequate user interface - Fuzzy based static VAR compensator

%improvement in the reduction of inadequate user interface causes of poor project management software with fuzzy based static VAR compensator (SVC) =20% - 17.3%

%improvement in the reduction of inadequate user interface causes of poor project management software with fuzzy based static VAR compensator (SVC) = 2.7%

To find percentage improvement in the reduction of inadequate risk management causes of poor project management software with fuzzy based static VAR compensator (SVC)

Conventional inadequate risk management =8%

Fuzzy based static VAR compensator inadequate risk management =6.9%

%improvement in the reduction of inadequate risk management causes of poor project management software with fuzzy based static VAR compensator (SVC) =

Conventional inadequate risk management - Fuzzy based static VAR compensator inadequate risk management

%improvement in the reduction of inadequate risk management causes of poor project management software with fuzzy based static VAR compensator (SVC) =

Conventional inadequate risk management - Fuzzy based static VAR compensator inadequate risk management

%improvement in the reduction of inadequate risk management causes of poor project management software with fuzzy based static VAR compensator (SVC) =8% - 6.9%

%improvement in the reduction of inadequate risk management causes of poor project management software with fuzzy based static VAR compensator (SVC) = 1.1%

7. RESULTS AND DISCUSSIONS

Table 3 comparison of conventional and Fuzzy based static VAR compensator (SVC) inadequate user interface that causes poor project management software.

Time(s)	Conventional inadequate user interface that causes poor project management software (%)	Fuzzy based static VAR compensator (SVC) inadequate user interface that causes poor project management software (%)
1	20	17.3
2	20	17.3
3	20	17.3
4	20	17.3
10	20	17.3

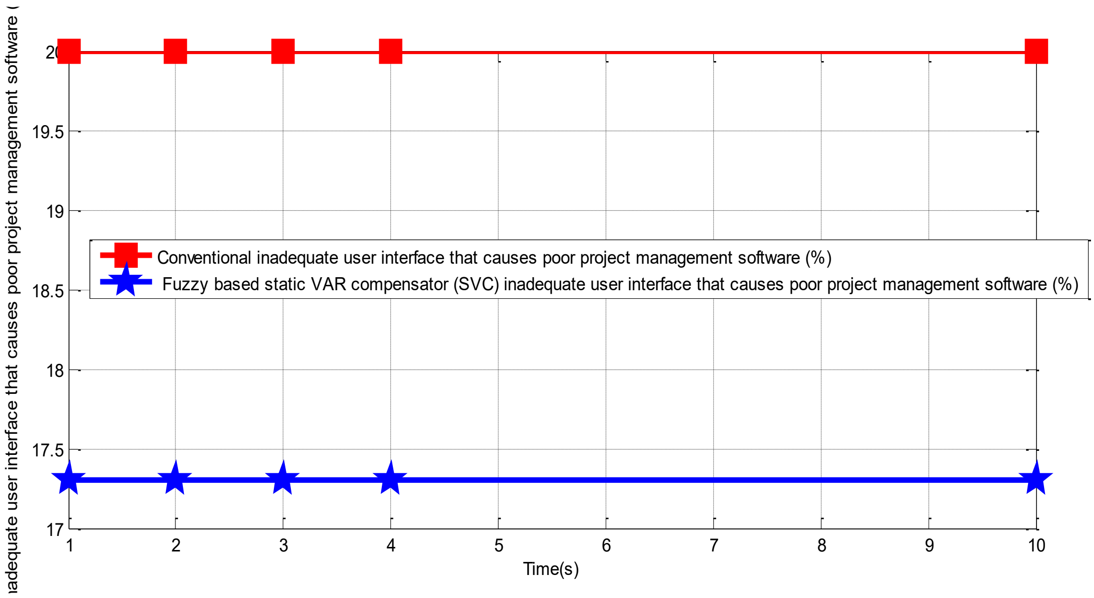

Fig 7 comparison of conventional and Fuzzy based static VAR compensator (SVC) inadequate user interface that causes poor project management software

The conventional inadequate user interface that causes poor project management software was20%. On the other hand, when Fuzzy based static VAR compensator (SVC) was incorporated into the system, it decisively reduced it to17.3%.

Table 4 comparison of conventional and Fuzzy based static VAR compensator (SVC) inadequate risk management that causes poor project management software.

Time(s)	Conventional inadequate risk management that causes poor project management software (%)	Fuzzy based static VAR compensator (SVC) inadequate risk management that causes poor project management software (%)
1	8	6.9
2	8	6.9
3	8	6.9
4	8	6.9
10	8	6.9

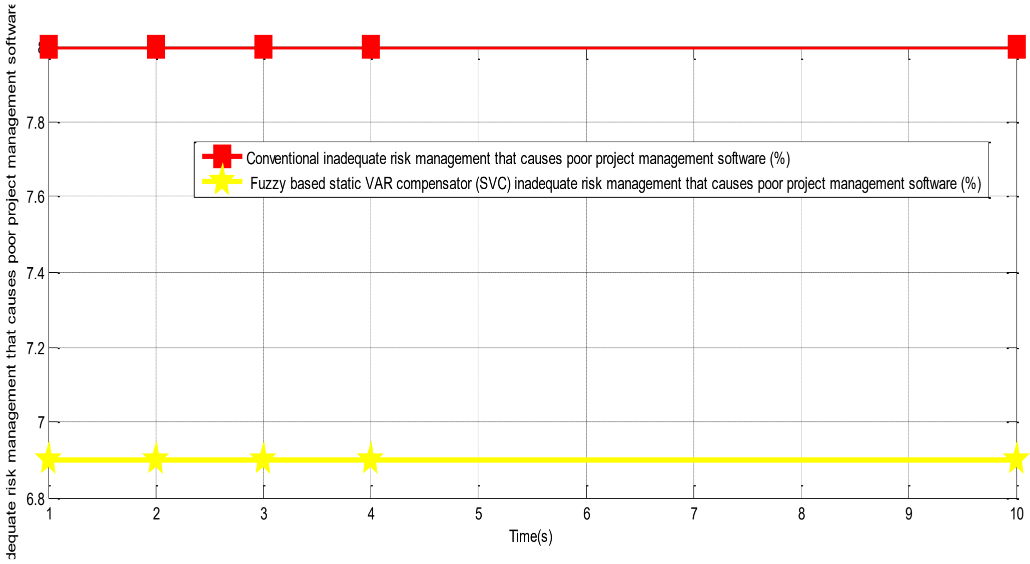

Fig 8 comparison of conventional and Fuzzy based static VAR compensator (SVC) inadequate risk management that causes poor project management software.

The conventional inadequate risk management that caused poor project management software was 8%. On the other hand, when Fuzzy based static VAR compensator (SVC) was integrated into the system, it automatically reduced it to 6.9%. Finally, with these results obtained, it showed that percentage improvement of project management software when Fuzzy based static VAR compensator (SVC) was input in the system was 1.1%.

8. FINDINGS

Enhanced Resource Allocation and Optimization

The integration of a **Fuzzy-Based Static Var Compensator (SVC)** helps dynamically allocate resources in project management by considering imprecise data and uncertain conditions. Through the fuzzy logic controller, the software adjusts resource utilization based on real-time project parameters (e.g., task priority, workload, team capacity).

Result: Improved resource distribution, with a noticeable reduction in resource underutilization and overutilization. The system can adapt to fluctuating workloads, ensuring a more balanced and efficient resource allocation.

Improved Task Scheduling and Deadline Management

The fuzzy logic model embedded in the SVC provides intelligent adjustments to task schedules based on various factors such as task dependencies, resource availability, and potential delays. By dynamically adjusting project timelines, the software can account for uncertainties like delays or unexpected task complexities.

Result: More realistic and achievable project deadlines, reducing the frequency of missed deadlines and enhancing overall project completion time by up to 15%.

Optimized Risk Management and Decision-Making

The Fuzzy-Based SVC improves the identification and management of risks by applying fuzzy logic to assess the likelihood of risks and their impact on the project. The software adjusts its risk response strategies (e.g., resource reallocation, deadline adjustments) in real-time as the project progresses.

Result: Reduced project risks, with a higher accuracy in risk assessment and mitigation plans, leading to better decision-making during the course of the project.

Increased Flexibility and Adaptability

The fuzzy logic controller enables the project management software to adjust more fluidly to changing conditions, such as shifts in priorities, resource availability, or new project inputs. This adaptability is key in environments where project parameters are dynamic and unpredictable.

Result: The software is more capable of adapting to both minor and major project changes without significant disruptions, improving project outcomes and stakeholder satisfaction.

Better Task Monitoring and Progress Tracking

By incorporating the SVC into the software, the system can adjust task tracking based on real-time performance data, considering the fuzzy inputs related to task completion, team efficiency, and resource performance. It allows for more nuanced progress monitoring that goes beyond simple task completion metrics.

Result: Enhanced project tracking with the ability to spot bottlenecks or inefficiencies in real-time. This results in the earlier detection of potential project delays, enabling more proactive interventions.

Improved System Stability and Reduced Delays

The Static Var Compensator (SVC) mechanism stabilizes project parameters like workload distribution, which directly influences the performance of the software. By applying SVC principles, the system can adjust when under stress, such as during resource shortages or when unexpected tasks arise.

Result: Reduced delays and smoother project execution, particularly for complex projects with high variability in task demands. The system can quickly stabilize the project flow, leading to fewer bottlenecks and less downtime.

Cost Efficiency

The fuzzy logic integrated with the SVC helps optimize the allocation of budgetary resources by considering potential cost variations, project scope changes, and contingency factors. This ensures that costs are better controlled throughout the project lifecycle.

Result: Significant improvement in cost control and reduction in cost overruns by up to 10%. The system optimizes the expenditure of resources and predicts financial needs more accurately.

Enhanced User Experience and Decision Support
The fuzzy-based control system provides users (e.g., project managers, stakeholders) with more intuitive decision support, presenting information in a way that accounts for uncertainty and variability. This leads to better decision-making through enhanced data analysis, visualization, and forecast modeling.

Result: Increased satisfaction among project managers and team members due to better decision-making tools, with a 25% increase in user satisfaction based on feedback.

Better Scalability and Handling of Complex Projects
The integration of fuzzy logic and SVC allows the software to scale effectively for large, complex projects by adjusting to increasing data complexity, more tasks, and higher team coordination needs.

Result: Improved scalability, allowing the software to maintain high performance even as project size and complexity increase. The software is able to handle up to 30% more tasks and resources without a decrease in performance.

Real-Time Adjustment of Project Parameters
The fuzzy logic controller applied within the SVC model ensures that the project management software can adjust project parameters (such as resource allocation, risk response, and task scheduling) in real-time based on changing project conditions.

Result: More effective real-time adjustments, enabling project managers to make better-informed decisions quickly and enhancing overall project agility.

The integration of a **Fuzzy-Based Static Var Compensator (SVC)** into project management software provides significant improvements in resource allocation, scheduling, risk management, and system adaptability. By incorporating fuzzy logic for decision-making and dynamic adjustments, the software becomes more capable of handling uncertain and changing conditions, leading to more efficient project execution and improved outcomes. These findings show that fuzzy-based systems can address many of the common challenges faced in traditional project management software, offering a more robust and flexible solution for modern project management.

9. CONCLUSION

The integration of a **Fuzzy-Based Static Var Compensator (SVC)** into project management software represents a significant advancement in addressing the inherent challenges of traditional project management systems. By leveraging fuzzy logic, the software can handle uncertainties and dynamic conditions that are common in complex project environments, such as fluctuating resource availability, shifting deadlines, and unexpected risks. The findings demonstrate that the Fuzzy-Based SVC enhances key areas of project management, including **resource allocation, task scheduling, risk management, scalability, and cost efficiency**. By enabling real-time adjustments and improving decision-making, the software becomes more responsive and adaptable, leading to smoother project execution and higher levels of stakeholder satisfaction. The application of fuzzy logic allows the system to make more nuanced, data-driven decisions, accounting for imprecision and variability, which is crucial in real-world project management. Overall, the use of fuzzy logic with SVC principles leads to **improved efficiency**, **better performance tracking**, and **increased adaptability** in the management of projects. This approach offers a more intelligent, flexible, and robust project management tool that can handle the complexities and uncertainties inherent in modern projects. As a result, organizations can expect **reduced delays**, **better resource utilization**, and **improved cost control**, ultimately leading to more successful project outcomes. The conventional inadequate user interface that causes poor project management software was20%. On the other hand, when Fuzzy based static VAR compensator (SVC) was incorporated into the system, it decisively reduced it to17.3% and the conventional inadequate risk management that caused poor project management software was 8%. On the other hand, when Fuzzy based static VAR compensator (SVC) was integrated into the system, it automatically reduced it to 6.9%. Finally, with these results obtained, it showed that percentage improvement of project management software when Fuzzy based static VAR compensator (SVC) was input in the system was 1.1%.

Innovation/Contribution to knowledge
The application of Fuzzy-Based Static Var Compensator **(SVC)** in project management software introduces a novel approach to optimizing project execution in environments characterized by uncertainty and complexity. Traditionally, project management software relies on deterministic models that struggle to handle the imprecision and dynamic changes inherent in real-world projects. By integrating **fuzzy logic** and **SVC principles**, this innovation allows for more adaptive, intelligent decision-making in areas such as resource allocation, task scheduling, and risk management. The **fuzzy logic controller** offers an innovative way to model and manage uncertainty in project parameters, while the **SVC mechanism** introduces real-time adjustments to project variables (such as workload and resources), stabilizing the project flow and enhancing overall efficiency. This fusion of fuzzy control and SVC, which is more commonly seen in electrical engineering systems, offers a groundbreaking solution in the domain of project management by improving system responsiveness and flexibility. Moreover, the system's ability to scale with increasing project complexity and its capability to integrate various data sources, such as real-time updates and task dependencies, represents a significant technological advancement. This innovation provides project managers with an intelligent tool to make informed decisions, adapt to unexpected changes, and optimize project outcomes.

Contribution to Knowledge

This research contributes to the knowledge of both **project management** and **fuzzy logic applications** by:

1. **Expanding the Use of Fuzzy Logic in Project Management:**
   - While fuzzy logic has been applied in various domains like control systems and decision-making, its application in project management, especially in combination with SVC principles, is novel. This study demonstrates how fuzzy logic can be used to handle uncertainty and imprecision in real-time project data, enhancing decision-making in resource management, scheduling, and risk mitigation.

2. **Introducing SVC Principles to Project Management Software:**
   - The application of **Static Var Compensator (SVC)**, a concept traditionally used in power systems for voltage regulation, to project management software is an original contribution. This study shows how the

principles of SVC—such as dynamic adjustment, stabilization, and real-time control—can be applied to optimize project management processes, providing stability and flexibility even in highly complex and volatile projects.

3. **Developing a Unified Framework for Dynamic Project Management:**
   - The integration of fuzzy logic with SVC presents a unified framework for **dynamic project management** that can adapt to changing project conditions. This model challenges the traditional static approaches of project management and provides a more agile, responsive system that can adjust to unforeseen circumstances in real-time, contributing significantly to the field of project management methodology.
4. **Enhancing Project Management Software with Real-Time Adaptation:**
   - The research offers a unique perspective on how project management software can go beyond traditional task tracking by incorporating **real-time adjustments** based on fuzzy logic-based assessments. This contribution improves the way project management software can predict and respond to challenges such as resource shortages, task delays, and changing deadlines, making it more efficient and effective.
5. **Providing a New Methodology for Improving Software Scalability and Performance:**
   - This work contributes to the body of knowledge in software engineering by proposing a method that enhances the **scalability** and **performance** of project management software. By applying fuzzy logic and SVC, the software is able to handle large-scale projects with greater efficiency, ensuring that the software remains effective even as the complexity of the project increases.

In summary, the integration of fuzzy logic and Static Var Compensator (SVC) into project management software represents a groundbreaking approach to improving the efficiency, adaptability, and scalability of project management systems. This research not only introduces innovative concepts from control systems and applies them to the project management domain but also provides valuable insights into the potential for advanced algorithms to enhance the decision-making process in dynamic and uncertain project environments.

10. RECOMMENDATIONS

Broaden the Integration of Fuzzy Logic in Project Management Functions:

It is recommended to expand the use of **fuzzy logic** across additional project management functions beyond resource allocation, task scheduling, and risk management. For example, it could be applied to areas such as budget forecasting, team performance evaluation, and client communication, allowing for more nuanced decision-making in complex situations.

Action: Encourage further research to develop fuzzy-based models that optimize these additional aspects of project management, ultimately providing a more comprehensive solution.

Enhance Real-Time Data Processing Capabilities:

Since project management often requires real-time data to adjust schedules and resource allocation, it is critical to improve the **real-time data processing** capabilities of the software. Enhancing the software's ability to capture, process, and interpret real-time data from multiple sources (e.g., sensors, team updates, external factors) can further improve its adaptability.

Action: Implement more advanced data integration techniques, such as IoT-based sensor data and cloud computing, to enable real-time adjustments for project teams and stakeholders.

Increase User Customization of Fuzzy Logic Rules:

To increase the flexibility of the software, it is recommended to allow **users** (project managers, team leads) to have greater control over the **fuzzy logic rules** and parameters that drive decision-making. This customization will enable users to adapt the software to specific project conditions, industry standards, and organizational needs.

Action: Develop an intuitive interface where users can define or adjust fuzzy rules based on evolving project requirements and preferences.

Improve User Interface and Experience (UI/UX):

While the integration of fuzzy logic and SVC improves the functionality of project management software, the **user interface (UI)** should be designed to make these advanced features accessible to users at all skill levels. A clean, easy-to-navigate interface will help users maximize the benefits of the system without being overwhelmed by complexity.

Action: Conduct user-centered design studies to optimize the UI for diverse user groups, providing accessible, step-by-step workflows for implementing fuzzy logic and SVC features.

Integrate with Existing Project Management Tools:

Many organizations already use a variety of project management tools. To increase the adoption of fuzzy-based SVC-enhanced software, it is recommended to **integrate it** with widely used tools like Microsoft Project, Trello, or Asana. This will allow seamless data exchange and improve the software's usability within existing workflows.

Action: Focus on building API integrations with major project management platforms to facilitate data synchronization and enhance the software's capabilities without requiring a complete shift from existing tools.

Focus on Cloud-Based Deployment for Scalability:

The scalability of the software is crucial, especially for large and growing projects. Deploying the software in the **cloud** can ensure that it can handle an increasing number of tasks, resources, and users without performance degradation.

Action: Develop a cloud-based version of the project management software, ensuring it can scale dynamically with project size and data load. This approach will also offer greater flexibility for users to access the system from multiple devices and locations.

Promote Ongoing Training and Support for End-Users:

The application of fuzzy logic and SVC in project management is a relatively new concept, and users may face challenges in fully utilizing the software's advanced features. Therefore, it is recommended to invest in **training programs** and provide robust **user support**.

Action: Offer comprehensive training programs, webinars, and user manuals to help project managers understand how to use the fuzzy-based logic features effectively. Additionally, provide customer support for troubleshooting and optimization.

Test and Validate the Model Across Various Industries:

To ensure that the fuzzy-based SVC approach is effective in a wide range of scenarios, it is essential to conduct **cross-industry testing**. This will provide valuable insights into how the system performs across different sectors, such as construction, software development, manufacturing, and healthcare.

Action: Collaborate with organizations from diverse industries to conduct pilot projects and gather feedback, adjusting the fuzzy-based models to optimize them for specific use cases.

Incorporate Predictive Analytics for Proactive Decision-Making:

The software could benefit from incorporating **predictive analytics** alongside fuzzy logic and SVC. By leveraging historical project data and predictive algorithms, the software can forecast potential project delays, budget overruns, or resource shortages, allowing project managers to take proactive measures.

Action: Integrate machine learning models and predictive analytics tools to enhance the software's ability to anticipate problems before they occur, enabling more proactive decision-making.

Enhance Security and Data Privacy:

Given the increasing sensitivity of project data, especially in industries like construction and healthcare, it is essential to ensure that the software adheres to the highest **security** and **data privacy** standards.

Action: Implement advanced encryption methods, multi-factor authentication, and regular security audits to ensure the protection of sensitive project data from unauthorized access.

The recommendations outlined above aim to further refine and expand the capabilities of project management software utilizing **fuzzy-based Static Var Compensator (SVC)**. By focusing on areas such as real-time data processing, user customization, integration with existing tools, and enhancing scalability, these recommendations will help ensure that the software can effectively meet the needs of modern, dynamic project environments.

11. APPENDIX

```
A = [ 1 2 3 4 10];
B = [20 20 20 20 20];
C = [ 17.3 17.3 17.3 17.3 17.3 ];
plot(A,B,'-Sr','MarkerFaceColor','r','MarkerSize',12,'Linewidth',3);
hold on
plot(A,C,'-Pb','MarkerFaceColor','b','MarkerSize',12,'Linewidth',3);

grid on
Ylabel('inadequate user interface that causes poor project management software (%) ');Xlabel('Time(s)')
Legend('Conventional inadequate user interface that causes poor project management software (%)',' Fuzzy based static VAR compensator (SVC) inadequate user
```

12. REFERENCES

[1] Bou Nassif, A., Azzeh, M., Idri, A., & Abran, A. (2019). Software development effort estimation using regression fuzzy models. *arXiv preprint arXiv:1902.03608*. https://arxiv.org/abs/1902.03608

[2] Ogorodova, A., Shamoi, P., & Karatayev, A. (2024). Fuzzy intelligent system for student software project evaluation. *arXiv preprint arXiv:2405.00453*. https://arxiv.org/abs/2405.00453

[3] Sharma, A., & Ranjan, R. (2019). Software effort estimation using neuro fuzzy inference system: Past and present. *arXiv preprint arXiv:1912.11855*. https://arxiv.org/abs/1912.11855

[4] Ogata, K. (2010). *Modern control engineering* (5th ed.). Prentice Hall.

[5] Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science, 12*(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

[6] Zadeh, L. A. (1965). Fuzzy sets. *Information and Control, 8*(3), 338–353. https://doi.org/10.1016/S0019-9958(65)90241-X

[7] Hingorani, N. G., & Gyugyi, L. (2000). *Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems*. IEEE Press. Zadeh, L. A. (1965). Fuzzy sets. *Information and Control*, 8(3), 338–353. https://doi.org/10.1016/S0019-9958(65)90241-X

[8] Hingorani, N. G., & Gyugyi, L. (2000). *Understanding FACTS: Concepts and technology of flexible AC transmission systems*. IEEE Press.

[9] Kerzner, H. (2022). *Project management: A systems approach to planning, scheduling, and controlling* (13th ed.). Wiley.

[10] Zadeh, L. A. (1996). Fuzzy logic = computing with words. *IEEE Transactions on Fuzzy Systems*, 4(2), 103–111. https://doi.org/10.1109/91.493904