Experiment No. 2: Literature Survey on Software Development Methodology

❖ Aim:

To conduct a literature survey on various software development models and select the most suitable model for the project based on its requirements, constraints, and desired outcomes.

❖ Theory:

The selection of an appropriate software development model is crucial to the success of a software project. Various models provide structured approaches to plan, execute, and manage projects effectively.

1. Popular Software Development Models**:**
    - Waterfall Model**:** Sequential and phase-based approach.
    - Iterative Model: Repeated refinement of software prototypes.
    - Agile Model: Focus on incremental delivery and adaptability.
    - Spiral Model: Emphasis on risk management with iterative cycles.
    - V-Model: Testing and development occur simultaneously.
2. Criteria for Selecting a Model**:**
    - Project Type and Size: Small vs. large-scale projects.
    - Flexibility and Risk: Dynamic requirements and risk mitigation.
    - Stakeholder Involvement: Frequency and depth of collaboration.
    - Timeline and Budget: Strict deadlines and resource constraints.

The literature survey allows teams to understand these models and select the one that aligns best with their project's objectives and constraints.

❖ Literature survey:

Journal Name and Year	Paper Title	Methodology	Key Finding	Research Gap
International Journal of Research and Applied Technology (2022)	The Systematic Literature Review of the Spiral Development Model: Topics, Trends, and Application Areas	Systematic Literature Review (SLR) from 2012-2022, analyzing 36 papers across various fields	The study shows that the **spiral model** is primarily applied in **software development** (19 papers) and **education** (17 papers), with notable peaks in usage during **2016** and **2021**. This indicates a trend where the model is favored for its iterative approach and risk management capabilities. However, the effectiveness of the spiral model may vary significantly across different sectors, suggesting that tailored applications are necessary for optimal results.	The study highlights a significant **research gap** in the understanding of the **spiral model's applicability** across various industries beyond software and education. While the model has been extensively studied in these areas, its potential in sectors like **healthcare**, **manufacturing**, and **service industries** remains largely unexplored. This gap indicates a need for comprehensive research to identify how the spiral model can be adapted and implemented effectively in these diverse contexts. Additionally, there is a scarcity of **empirical studies** that assess the real-world effectiveness and outcomes of the spiral model, which could provide critical insights into best practices and areas for improvement.
International Journal of Advanced Multidisciplinary Research and Studies (2022)	Critical Evaluation of Waterfall Project Management Methodology: A Case Study of Digital Management Conference Project	Case study analyzing the application of waterfall methodology in a digital management conference project.	The case study demonstrates that the **waterfall methodology** is effective in achieving project goals when requirements are clearly defined. However, it reveals critical limitations in flexibility, making it challenging to adapt to unforeseen changes during project execution. This highlights the need for further research comparing waterfall with agile methodologies to enhance adaptability and responsiveness in project management.	The research identifies a notable gap in the **waterfall methodology's ability** to accommodate changes during project execution. While it performs well with well-defined requirements, its rigidity poses challenges in dynamic environments where adaptability is crucial. This limitation suggests a need for further **comparative research** between waterfall and agile methodologies to explore how traditional project management frameworks can evolve to better handle unforeseen changes. Moreover, there is a lack of studies focusing on hybrid approaches that could integrate the strengths of both methodologies to enhance flexibility and responsiveness in project management practices.

Journal Name and Year	Paper Title	Methodology	Key Finding	Research Gap
Conference on AI Engineering Software Engineering for AI (CAIN 2024) (2024)	An Exploratory Study of V-Model in Building ML-Enabled Software: A Systems Engineering Perspective	Qualitative study involving interviews with 11 practitioners from multiple software companies to explore the application of V-Model for ML-enabled systems.	The qualitative study indicates that the **V-Model** effectively addresses collaboration challenges in developing **machine learning (ML)** systems by emphasizing system decomposition, validation, and verification. Despite its strengths, implementing the V-Model requires significant effort. The findings suggest a need for further exploration of process models that integrate V-Model characteristics to improve interdisciplinary collaboration in ML projects.	The study points out a significant gap in the exploration of new **process models** that leverage V-Model characteristics for managing interdisciplinary collaborations effectively within **machine learning (ML)** projects. Although the V-Model addresses several collaboration challenges, its implementation requires considerable effort, indicating that there may be opportunities to refine or adapt it for better efficiency. Future research should focus on developing innovative methodologies that combine V-Model principles with other frameworks to enhance collaboration and streamline processes in complex software development environments. Furthermore, there is a need for empirical studies to validate these new models and assess their effectiveness in real-world applications.

❖ Summary Literature survey:

The literature survey examines three important papers on software development methodologies. The first paper, from the *International Journal of Research and Applied Technology* (2022), reviews the spiral model's use primarily in software and education, noting a lack of understanding of its application in other sectors. The second paper, published in the *International Journal of Advanced Multidisciplinary Research and Studies* (2022), critiques the waterfall methodology through a case study, highlighting its effectiveness for defined projects but its rigidity in adapting to changes, advocating for comparisons with agile methods. Lastly, an exploratory study presented at CAIN 2024 investigates the V-Model in developing machine learning-enabled software, proposing eight propositions for its effective use and calling for further research into enhancing interdisciplinary collaboration. Together, these papers shed light on the strengths and limitations of various software development approaches.

❖ Learning Objective:

- To understand different software development models and their characteristics.
- To analyze the pros and cons of various models.
- To select the most suitable model for the project based on the findings.

❖ Learning Outcome:

At the end of this experiment, students will be able to:

1. Identify and describe various software development models.
2. Evaluate the suitability of each model for specific project scenarios.
3. Select and justify the choice of a model for their project.

❖ Course Outcomes (COs):

- CO1: Understand and explain the fundamentals of software engineering, the software process frameworks, and umbrella activities to manage and improve software development.
- CO2: Analyze and compare traditional and agile software development models, including their applicability to various project scenarios.

❖ Cognitive Levels of Attainment as per Bloom's Taxonomy:

- L1 (Remember)**:** Identify and list various software development models.
- L2 (Understand)**: Explain the characteristics and advantages of different models.**
- L4 (Analyze)**: Evaluate the strengths and weaknesses of models to select the most suitable one for the project.**

❖ Programme Outcome (PO) Attainment:

- PO1: Engineering Knowledge: Apply knowledge of engineering fundamentals to understand software development models.
- PO2: Problem Analysis: Analyze the characteristics of various models to solve complex problems.
- PO5: Engineering Tool Usage: Utilize research tools and resources to perform a detailed literature survey.

- PO11: Life-Long Learning: Develop the ability to explore and evaluate emerging software engineering models.

❖ **Programme Specific Outcome (PSO) Attainment:**

- PSO1: Apply software engineering knowledge to select sustainable and efficient development models for IT projects.

❖ **Result & Discussion:**

- **Result**:

    1. Identified and documented the characteristics of various software development models.
    2. Evaluated each model's applicability to the project scenario.
    3. Selected the most suitable model for the project and justified the choice.

- **Discussion:**

  The literature survey emphasized the importance of understanding different software development models to ensure their proper alignment with project requirements. The selected model balances flexibility, risk, and development speed.

❖ **Conclusion:**

A systematic literature survey provides a comprehensive understanding of software development models. Selecting the appropriate model ensures that the project adheres to timelines, meets stakeholder expectations, and mitigates potential risks effectively.

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Theoretical Background

Software development methodologies serve as structured approaches to software engineering, providing frameworks for planning, executing, testing, and maintaining software projects. Each model is rooted in theoretical concepts of software engineering, risk management, and project management principles.

- **Waterfall Model**: A linear-sequential approach, serving as the foundation for many models.
- **Iterative and Incremental Development (IID)**: The basis for Agile and Spiral models, emphasizing continuous refinement.
- **Risk-Driven Development (RDD)**: Central to the Spiral Model, focusing on identifying and mitigating risks throughout development.
- **Verification and Validation (V&V) Theory**: Essential for the V-Model, ensuring correctness at each phase.

Methodologies in Software Development

V-Model and Its Variants

The traditional V-Model follows a sequential software development process, emphasizing validation and verification at each stage. Its primary limitation is rigidity, which has led to the emergence of variations:

- **W-Model**: Enhances testing by integrating it earlier in the process, creating a parallel development-test cycle.
- **Sawtooth Model**: Incorporates iterative prototyping, allowing for early client feedback.
- **Sharktooth Model**: Introduces managerial oversight and abstraction layers to improve process adaptability.

Agile Methodologies

Agile is a collective term for methodologies emphasizing iterative, incremental development, adaptive planning, and collaboration. Key Agile frameworks include:

- **Scrum**: Utilizes short development cycles (sprints) to enhance adaptability.
- **Extreme Programming (XP)**: Promotes high-quality code through continuous integration and frequent releases.
- **Feature-Driven Development (FDD)**: Prioritizes functionality-based planning and delivery.
- **Dynamic Systems Development Method (DSDM)**: Offers structured Agile project management with iterative refinement.

Spiral Model

The Spiral Model, developed by Barry Boehm, integrates iterative risk assessment with systematic development. It is best suited for large-scale, high-risk projects. Applications include:

- **Website Development**: Facilitates modular, scalable solutions.
- **Mobile App Development**: Enhances cross-platform optimization.
- **Advanced Traffic Management Systems (ATMS)**: Supports real-time decision-making and dynamic adaptation.

Comparative Analysis of Models:

Model	Key Features	Advantages	Disadvantages
V-Model Variants	Sequential testing phases with variations (W-Model, Sawtooth, Sharktooth)	Structured approach, improved client involvement	Rigid structure, resource-intensive
Agile Model	Iterative and incremental development, customer collaboration	Flexibility, rapid delivery, enhanced user satisfaction	High workload, potential for scope creep
Spiral Model	Risk-driven iterative model	Strong risk management, adaptability	High resource demands, complex implementation

Key Findings and Research Gaps:

Journal Name	Year	Paper Title	Methodology	Key Findings	Research Gap
International Journal of Advanced Research in Computer Science	2021	Variations in V-Model for Software Development	Introduced W-Model, Sawtooth Model, and Sharktooth Model	Addressed V-Model limitations and improved testing approaches	Oversimplifies real-world complexities, lacks resource allocation details
Informatica Economică	2020	Agile Software Development	Literature review based on Agile Manifesto principles	Agile enhances adaptability, customer satisfaction, and efficiency	Needs deeper exploration of long-term sustainability and scalability
International Journal of Engineering Applied Sciences and Technology (IJEAST)	2021	Review of the Spiral Model and Its Applications	Combination of Waterfall, Evolutionary, and Prototyping models	Effective in risk-sensitive projects with iterative feedback	High resource requirements limit small-scale applicability

Conclusion and Future Directions:

Each software development model presents unique advantages and challenges:

- **V-Model Variants** improve testing structures but require resource-heavy planning.
- **Agile** fosters adaptability and customer collaboration but can be difficult to manage in large-scale projects.
- **Spiral Model** excels in risk-sensitive environments but demands extensive resources.

Future Research Directions:

- Enhancing the adaptability of the V-Model for dynamic project environments.
- Investigating Agile's impact on long-term technological advancements.
- Making the Spiral Model more accessible for small-to-medium-scale projects by optimizing resource efficiency.

The continuous evolution of software development methodologies ensures that new hybrid models will emerge, further bridging gaps between structured development and adaptability.

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The continuous evolution of software development methodologies ensures that new hybrid models will emerge, further bridging gaps between structured development and adaptability.

Experiment No:2

Literature Review on Software Development Models

Software development methodologies have evolved to enhance efficiency, risk management, and adaptability. Various models, such as the V-Model, Agile, and Spiral Model, address different challenges in software engineering. This literature review provides a detailed examination of these models, their theoretical underpinnings, methodologies, benefits, limitations, and research gaps.

Theoretical Background

Software development methodologies serve as structured approaches to software engineering, providing frameworks for planning, executing, testing, and maintaining software projects. Each model is rooted in theoretical concepts of software engineering, risk management, and project management principles.

- **Waterfall Model**: A linear-sequential approach, serving as the foundation for many models.
- **Iterative and Incremental Development (IID)**: The basis for Agile and Spiral models, emphasizing continuous refinement.
- **Risk-Driven Development (RDD)**: Central to the Spiral Model, focusing on identifying and mitigating risks throughout development.
- **Verification and Validation (V&V) Theory**: Essential for the V-Model, ensuring correctness at each phase.

Methodologies in Software Development

V-Model and Its Variants

The traditional V-Model follows a sequential software development process, emphasizing validation and verification at each stage. Its primary limitation is rigidity, which has led to the emergence of variations:

- **W-Model**: Enhances testing by integrating it earlier in the process, creating a parallel development-test cycle.
- **Sawtooth Model**: Incorporates iterative prototyping, allowing for early client feedback.
- **Sharktooth Model**: Introduces managerial oversight and abstraction layers to improve process adaptability.

Agile Methodologies

Agile is a collective term for methodologies emphasizing iterative, incremental development, adaptive planning, and collaboration. Key Agile frameworks include:

- **Scrum**: Utilizes short development cycles (sprints) to enhance adaptability.
- **Extreme Programming (XP)**: Promotes high-quality code through continuous integration and frequent releases.
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- **Dynamic Systems Development Method (DSDM)**: Offers structured Agile project management with iterative refinement.

Spiral Model

The Spiral Model, developed by Barry Boehm, integrates iterative risk assessment with systematic development. It is best suited for large-scale, high-risk projects. Applications include:

- **Website Development**: Facilitates modular, scalable solutions.
- **Mobile App Development**: Enhances cross-platform optimization.
- **Advanced Traffic Management Systems (ATMS)**: Supports real-time decision-making and dynamic adaptation.

Comparative Analysis of Models:

Model	Key Features	Advantages	Disadvantages
V-Model Variants	Sequential testing phases with variations (W-Model, Sawtooth, Sharktooth)	Structured approach, improved client involvement	Rigid structure, resource-intensive
Agile Model	Iterative and incremental development, customer collaboration	Flexibility, rapid delivery, enhanced user satisfaction	High workload, potential for scope creep
Spiral Model	Risk-driven iterative model	Strong risk management, adaptability	High resource demands, complex implementation

Key Findings and Research Gaps:

Journal Name	Year	Paper Title	Methodology	Key Findings	Research Gap
International Journal of Advanced Research in Computer Science	2021	Variations in V-Model for Software Development	Introduced W-Model, Sawtooth Model, and Sharktooth Model	Addressed V-Model limitations and improved testing approaches	Oversimplifies real-world complexities, lacks resource allocation details
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Conclusion and Future Directions:

Each software development model presents unique advantages and challenges:

- **V-Model Variants** improve testing structures but require resource-heavy planning.
- **Agile** fosters adaptability and customer collaboration but can be difficult to manage in large-scale projects.
- **Spiral Model** excels in risk-sensitive environments but demands extensive resources.

Future Research Directions:

- Enhancing the adaptability of the V-Model for dynamic project environments.
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Experiment No. 2: Literature Survey on Software Development Methodology

❖ Aim:

To conduct a literature survey on various software development models and select the most suitable model for the project based on its requirements, constraints, and desired outcomes.

❖ Theory:

The selection of an appropriate software development model is crucial to the success of a software project. Various models provide structured approaches to plan, execute, and manage projects effectively.

1. Popular Software Development Models**:**
    - Waterfall Model**:** Sequential and phase-based approach.
    - Iterative Model: Repeated refinement of software prototypes.
    - Agile Model: Focus on incremental delivery and adaptability.
    - Spiral Model: Emphasis on risk management with iterative cycles.
    - V-Model: Testing and development occur simultaneously.
2. Criteria for Selecting a Model**:**
    - Project Type and Size: Small vs. large-scale projects.
    - Flexibility and Risk: Dynamic requirements and risk mitigation.
    - Stakeholder Involvement: Frequency and depth of collaboration.
    - Timeline and Budget: Strict deadlines and resource constraints.

The literature survey allows teams to understand these models and select the one that aligns best with their project's objectives and constraints.

❖ Literature survey:

Journal Name and Year	Paper Title	Methodology	Key Finding	Research Gap
International Journal of Research and Applied Technology (2022)	The Systematic Literature Review of the Spiral Development Model: Topics, Trends, and Application Areas	Systematic Literature Review (SLR) from 2012-2022, analyzing 36 papers across various fields	The study shows that the **spiral model** is primarily applied in **software development** (19 papers) and **education** (17 papers), with notable peaks in usage during **2016** and **2021**. This indicates a trend where the model is favored for its iterative approach and risk management capabilities. However, the effectiveness of the spiral model may vary significantly across different sectors, suggesting that tailored applications are necessary for optimal results.	The study highlights a significant **research gap** in the understanding of the **spiral model's applicability** across various industries beyond software and education. While the model has been extensively studied in these areas, its potential in sectors like **healthcare**, **manufacturing**, and **service industries** remains largely unexplored. This gap indicates a need for comprehensive research to identify how the spiral model can be adapted and implemented effectively in these diverse contexts. Additionally, there is a scarcity of **empirical studies** that assess the real-world effectiveness and outcomes of the spiral model, which could provide critical insights into best practices and areas for improvement.
International Journal of Advanced Multidisciplinary Research and Studies (2022)	Critical Evaluation of Waterfall Project Management Methodology: A Case Study of Digital Management Conference Project	Case study analyzing the application of waterfall methodology in a digital management conference project.	The case study demonstrates that the **waterfall methodology** is effective in achieving project goals when requirements are clearly defined. However, it reveals critical limitations in flexibility, making it challenging to adapt to unforeseen changes during project execution. This highlights the need for further research comparing waterfall with agile methodologies to enhance adaptability and responsiveness in project management.	The research identifies a notable gap in the **waterfall methodology's ability** to accommodate changes during project execution. While it performs well with well-defined requirements, its rigidity poses challenges in dynamic environments where adaptability is crucial. This limitation suggests a need for further **comparative research** between waterfall and agile methodologies to explore how traditional project management frameworks can evolve to better handle unforeseen changes. Moreover, there is a lack of studies focusing on hybrid approaches that could integrate the strengths of both methodologies to enhance flexibility and responsiveness in project management practices.

Journal Name and Year	Paper Title	Methodology	Key Finding	Research Gap
Conference on AI Engineering Software Engineering for AI (CAIN 2024) (2024)	An Exploratory Study of V-Model in Building ML-Enabled Software: A Systems Engineering Perspective	Qualitative study involving interviews with 11 practitioners from multiple software companies to explore the application of V-Model for ML-enabled systems.	The qualitative study indicates that the **V-Model** effectively addresses collaboration challenges in developing **machine learning (ML)** systems by emphasizing system decomposition, validation, and verification. Despite its strengths, implementing the V-Model requires significant effort. The findings suggest a need for further exploration of process models that integrate V-Model characteristics to improve interdisciplinary collaboration in ML projects.	The study points out a significant gap in the exploration of new **process models** that leverage V-Model characteristics for managing interdisciplinary collaborations effectively within **machine learning (ML)** projects. Although the V-Model addresses several collaboration challenges, its implementation requires considerable effort, indicating that there may be opportunities to refine or adapt it for better efficiency. Future research should focus on developing innovative methodologies that combine V-Model principles with other frameworks to enhance collaboration and streamline processes in complex software development environments. Furthermore, there is a need for empirical studies to validate these new models and assess their effectiveness in real-world applications.

❖ Summary Literature survey:

The literature survey examines three important papers on software development methodologies. The first paper, from the *International Journal of Research and Applied Technology* (2022), reviews the spiral model's use primarily in software and education, noting a lack of understanding of its application in other sectors. The second paper, published in the *International Journal of Advanced Multidisciplinary Research and Studies* (2022), critiques the waterfall methodology through a case study, highlighting its effectiveness for defined projects but its rigidity in adapting to changes, advocating for comparisons with agile methods. Lastly, an exploratory study presented at CAIN 2024 investigates the V-Model in developing machine learning-enabled software, proposing eight propositions for its effective use and calling for further research into enhancing interdisciplinary collaboration. Together, these papers shed light on the strengths and limitations of various software development approaches.

❖ Learning Objective:

- To understand different software development models and their characteristics.
- To analyze the pros and cons of various models.
- To select the most suitable model for the project based on the findings.

❖ Learning Outcome:

At the end of this experiment, students will be able to:

1. Identify and describe various software development models.
2. Evaluate the suitability of each model for specific project scenarios.
3. Select and justify the choice of a model for their project.

❖ Course Outcomes (COs):

- CO1: Understand and explain the fundamentals of software engineering, the software process frameworks, and umbrella activities to manage and improve software development.
- CO2: Analyze and compare traditional and agile software development models, including their applicability to various project scenarios.

❖ Cognitive Levels of Attainment as per Bloom's Taxonomy:

- L1 (Remember)**:** Identify and list various software development models.
- L2 (Understand)**: Explain the characteristics and advantages of different models.**
- L4 (Analyze)**: Evaluate the strengths and weaknesses of models to select the most suitable one for the project.**

❖ Programme Outcome (PO) Attainment:

- PO1: Engineering Knowledge: Apply knowledge of engineering fundamentals to understand software development models.
- PO2: Problem Analysis: Analyze the characteristics of various models to solve complex problems.
- PO5: Engineering Tool Usage: Utilize research tools and resources to perform a detailed literature survey.

- PO11: Life-Long Learning: Develop the ability to explore and evaluate emerging software engineering models.

❖ **Programme Specific Outcome (PSO) Attainment:**

- PSO1: Apply software engineering knowledge to select sustainable and efficient development models for IT projects.

❖ **Result & Discussion:**

- **Result**:

    1. Identified and documented the characteristics of various software development models.
    2. Evaluated each model's applicability to the project scenario.
    3. Selected the most suitable model for the project and justified the choice.

- **Discussion:**

  The literature survey emphasized the importance of understanding different software development models to ensure their proper alignment with project requirements. The selected model balances flexibility, risk, and development speed.

❖ **Conclusion:**

A systematic literature survey provides a comprehensive understanding of software development models. Selecting the appropriate model ensures that the project adheres to timelines, meets stakeholder expectations, and mitigates potential risks effectively.

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    2. Evaluated each model's applicability to the project scenario.
    3. Selected the most suitable model for the project and justified the choice.

- **Discussion:**

  The literature survey emphasized the importance of understanding different software development models to ensure their proper alignment with project requirements. The selected model balances flexibility, risk, and development speed.

❖ **Conclusion:**

A systematic literature survey provides a comprehensive understanding of software development models. Selecting the appropriate model ensures that the project adheres to timelines, meets stakeholder expectations, and mitigates potential risks effectively.