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Systematic Review of Project Life Cycle of AI Tools and AI Enabled Projects: A Study Based on Best Development Practices.

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Abstract : The development and deployment of AI tools necessitate a structured approach that adheres to best practices throughout the project life cycle to ensure their effectiveness, reliability, and ethical compliance. This systematic review aims to identify and analyze the best development practices followed in the project life cycle of AI tools, spanning from problem identification to maintenance and monitoring. By examining a diverse array of scholarly articles, case studies, and industry reports, this study synthesizes key practices and methodologies that contribute to successful AI projects. The findings highlight crucial practices in various stages, including data collection and preparation, model development and training, model evaluation and validation, deployment and integration, and ongoing maintenance. This review provides valuable insights and practical guidelines for AI practitioners and researchers, facilitating the optimization of AI development processes and promoting the creation of robust, scalable, and ethically sound AI solutions.

Keywords : *Project life cycle, AI tools, best practices, systematic review, development practices, AI development, data preparation, model training, model validation, deployment, maintenance.*

INTRODUCTION

Artificial Intelligence (AI) has become a cornerstone of technological advancement, revolutionizing industries such as healthcare, finance, transportation, and more. According to Statista, the global revenue from the Artificial Intelligence (AI) software market is projected to reach $126 billion by 2025. Gartner reports that 37% of organizations have implemented AI in some form, indicating not only a growing acceptance of AI technology but also an increasing integration of AI skills into business processes. Over the past four years, the percentage of enterprises employing AI has surged by 270%. Servion Global Solutions predicts that by 2025, 95% of customer interactions will be powered by AI. Additionally, a 2020 report from Statista reveals that the global AI software market is expected to grow by approximately 54% year-on-year, reaching a forecast size of $22.6 billion. The proliferation of AI tools and applications underscores the critical need for structured development practices that ensure their reliability, scalability, and ethical integrity. As AI systems increasingly influence decision-making processes and operational workflows, the importance of adhering to best practices throughout the project life cycle cannot be overstated. The project life cycle of AI tools encompasses several stages, from the initial problem identification and requirement analysis to data collection and preparation, model development and training, model evaluation and validation, deployment and integration, and ongoing maintenance and monitoring. Each stage presents unique challenges and opportunities, requiring meticulous planning, execution, and evaluation to achieve desired outcomes. Despite the growing body of literature on AI development, there remains a lack of comprehensive reviews that systematically analyze best practices across the entire project life cycle. Existing studies often focus on specific aspects, such as model training techniques or data management strategies, without providing an integrated view of the end-to-end process. This gap in the literature highlights the need for a systematic review that consolidates knowledge from diverse sources and offers a holistic perspective on AI development best practices. This study aims to fill this gap by conducting a systematic review of the project life cycle of AI tools, with a focus on identifying and analyzing the best development practices followed across different stages. By synthesizing findings from scholarly articles, case studies, and industry reports, this review seeks to provide valuable insights and practical guidelines for AI practitioners and researchers. The goal is to facilitate the optimization of AI development processes, promoting the creation of robust, scalable, and ethically sound AI solutions.

The remainder of this paper is structured as follows: the

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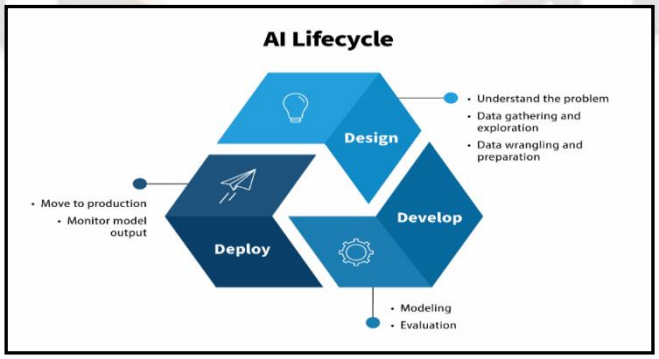
methodology section outlines the approach taken to conduct the systematic review, including the search strategy, inclusion and exclusion criteria, and data extraction methods. The literature review section provides an overview of the AI project life cycle stages and summarizes the best practices identified in each stage. The results section presents the synthesized findings, highlighting common themes and practices. The discussion section explores the implications of these findings, addresses common challenges and limitations, and suggests directions for future research. Finally, the conclusion summarizes the key insights and offers recommendations for AI development.

A. LITERATURE REVIEW

A research paper by Ayoola Oke (2008), titled "A literature review on artificial intelligence" published in International Journal of Information and Management Sciences 19(4):535-570 - 19(4):535-570. The paper presents a comprehensive, concise, and elegantly distilled overview of the state-of-the-art in artificial intelligence (AI), highlighting experiences and advancements in the field. Specifically, it offers an extensive review of recent developments in AI and its applications. The work is designed to assist newcomers to the AI field while also reminding experienced researchers of familiar issues. In a paper titled 'Artificial Intelligence Applied to Project Success: A Literature Review" published in January 2015 , in the journal International Journal of Interactive Multimedia and Artificial Intelligence 3(5):77-84 - 3(5):77-84 by Daniel Magaña and Juan Carlos Fernández Rodríguez, concludes that Critical success factors identification: are Neural Networks, Fuzzy Cognitive Maps,. Genetic Algorithms and Bayesian Model A review paper titled "Artificial Intelligence-Based Life Cycle Engineering in Industrial Production: A Systematic Literature Review", by Hamidur Rahman, Ricky Stanley D'cruze, Mobyen Uddin Ahmed, Rickard Sohlberg, Tomohiko Sakao, And Peter Funk in the year 2022, in IEEE Access discuss the areas where AI can be applied, which AI / ML methods that can be used. The paper is based on secondary data collected from different articles. In an article "Generative AI Project Life Cycle" by Aymal Khalid Khan who is a Upwork Expert, Vetted Software Engineer, suggest that there are 4 main phases in a AI project life cycle, namely problem definition, model selection, adapt and align model, Application integration. Another articled title "Operationalizing AI" by John J. Thomas, William Roberts, Paco Nathan, the major phases in the life cycle are mentioned as scope definition, understanding the data, building a model, deploy, manage and trust. In a PowerPoint uploaded by Nilay Pande in 2022, titled 'AI Project Life Cycle", though the project macro level phases remain to be initiation phase, planning phase, implementation phase and execution phase, at micro level, the steps are little different. These steps are identified as problem scoping, data acquisition, data exploration, modelling and evaluation.

One more article exclusively dedicated to the life cycle of AI projects, the major phases are identified as problem definition, data investigation, data preparation, development of model, evaluation of model, deployment, monitoring and improvement. Further, a cyclic model of these activities is mentioned in the article. (The article is available on the link https://www.datascience-pm.com/the- genai-life-cycle/) .An article available on the link https://coe.gsa.gov/coe/ai-guide-for-government/understanding- managing-ai-lifecycle/, there is further clarity about the activities under each phase in AI project life cycle. The figure available on the URL, shows 3 major phases along with further bifurcation of each of the phase.



B. RESEARCH METHODOLOGY

Success of any software can be largely attributed to the process of development and quality checks followed stringently. In traditional software development, whether waterfall model or spiral or prototyping model followed for development of software, thorough requirement gathering, communication with the end users and clients play critical role in a development of good quality software, with lesser

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number of bugs.
In case of agile model of development, continuous interaction between developers and clients as well as faster pace of software development do affect the success of the software product.
Comparatively, a lot is yet to be explored about development of AI tools (AI based projects). The paper aims at identifying the life cycle stages followed by developers while developing AI tools / AI based projects and pin point some best practices in the process.

C. OBJECTIVES OF THE RESEARCH

- To identify the steps followed by software developers during AI tools / AI based project life cycle
- To mark the mile stones in the AI tools / AI based project life cycle
- To identify best practices followed by software developers while developing AI tools / AI- based projects

D. RESEARCH QUESTIONS

RQ1 – Which steps do the developers involved in AI tools development or AI based projects follow? RQ2 – What are the mile stones in AI project life cycle?
RQ3 – What are the best practices followed by the developers during development of AI tools / AI based projects?

E. SAMPLE SELECTION

As the respondents for the study are expected to be having some experiencing in AI tool development or AI-based projects, the respondents were identified by purposive sampling technique and snowball sampling technique.

K. DATA COLLECTION

Process for collecting the data and the time period for collecting data hamper the quality of outcomes of the research. The researcher joined 8 groups on social media which involved majority of AI developers. A questionnaire in the form of google form was rolled out to the members of the groups. A questionnaire was circulated to 234 members of different group. Out of 234 members, 189 participants reverted back with the filled questionnaire. Questionnaire (data collection tool) was tested with chi-square test with a pilot sample of 30 responses. Also, the questionnaire was checked by experts in the area, working as project managers.

L. ANALYSIS OF THE RESPONSES

Study being mainly exploratory in nature, the aim was to understand the basics of AI project life cycle. Responses of open-ended questions in the questionnaire were analysed for content analysis. The questions with options and ratings were analysis using SPSS for quantitative analysis.
Following are the major findings:
1. Major phases in the life cycle

Three major phases in any AI project life cycle can be identified as Design, Develop and Deploy. These can be further described in detail as DesignUnderstand the Problem: Begin by identifying the key project objectives and requirements to share your team's understanding of their mission challenge. Define the desired outcome from a business perspective and determine how AI can solve this problem. For more details, refer to the "Framing AI Problems" section.
Data Gathering and Exploration: Collect and evaluate the data required to build the AI solution. This involves discovering available datasets, identifying data quality issues, and deriving initial insights and perspectives on a data plan.Data Wrangling and Preparation: Transform the raw data into a format that the model can use. This phase, though time-consuming and tedious, is critical for developing a model that meets the goals established in the first step.
No AI solution will succeed without a clear and precise understanding of the business challenge and desired outcome. Data is the foundation of any AI solution. Understanding the data required and its composition is crucial. Data preparation is often the hardest and most time-consuming phase of the AI lifecycle. Develop Modelling: Experiment with data to determine the right model. This involves training, testing, evaluating, and retraining multiple models to find the best one and the appropriate settings to achieve the desired outcome. The model training and selection process is interactive and iterative, requiring fine-tuning to produce the desired results. For more information on machine learning and models Computational Requirements: Depending on the data's amount and type, the training process can be computationally expensive, requiring special equipment for sufficient computing power.
Evaluation: Test the models on new data to ensure they generalize well and meet business goals. This step is critical and is discussed in greater detail in the "Test and Evaluation" section.

Deploy

Move to Production: Once the model meets the expected outcome and performs well, deploy it into a production environment to process new data not part of the training cycle. Monitor Model Output: Continuously monitor the model as it processes live data to ensure it produces the intended outcomes. This process, known as generalization, ensures the model adapts properly to new, unseen data. Monitor for "drift," where performance changes over time, and update the

model as needed. Use an agile approach to continuously retrain and refresh the model. AI systems require rigorous and continuous monitoring and maintenance to ensure they continue to perform as trained, meet the desired outcomes, and solve business challenges.

2. Critical success factors

Understanding of business and the use case undertaken does have bearing on decision of choosing the right model and algorithm. Lots of readily available foundation models by Google, Meta and OpenAI also drastically change the micro steps in any AI project life cycle.

Instead of building one, choosing right model and customising with proprietary / local data can save lot of efforts and cost.

Procuring / choosing right data (authentic) can make an AI tool / project success or failure. Preparing the data for training phase is also one of the important aspects of AI project. Cleaning, SMOTEing or deleting data for balancing purposes may require strategy building at managerial level. Right amount of time and number of iterations for training a model is also a deciding factor. Excell training duration or number of iterations may result into overfitting or on the other hand, insufficient duration and number of iterations may result into underfitting.

3. Deployment of AI Solutions can be achieved through different options such as:

Ready-to-Use AI Algorithms or Models: This approach is suitable when existing solutions can address your task without needing customization. If the task is too complex for a single solution, consider breaking it down into simpler sub-tasks and finding appropriate algorithms for each. Customization of a Ready Solution: Often, a ready-made dataset or pretrained model won't meet your project goals out of the box. In such cases, you'll need to make adjustments before using these solutions or components. This might involve improving data labelling, expanding the dataset with new data, or training the pretrained model on custom data. Development of a Custom AI Solution: This scenario is typically challenging and costly, suitable for complex, unprecedented use cases. However, even the most unique and complex AI projects can often be divided into smaller tasks. Only a few of these smaller tasks usually require building a custom AI from scratch. Sufficient, trustworthy data with proper labels which is free of any bias can be best suited for AI projects.

Based on use cane and business requirements, right choice of one of the options or combination can result into acquiring appropriate results.

4. Legal / ethical and social implication

Success of AI tool / AI based project is largely dependent on the data used for training and testing the tool.

Data Privacy and security, if not taken care of, can lead to havoc when implementation. Copyrighted contents / contents with sensitive information used for training a model can attract legal actions later. Further, unauthentic data fed to a model may result into hallucination i.e. generation of bogus contents.

5. Non-AI elements of an AI tool / AI enabled project

Non-AI element of ana AI tool / AI enabled project also requires enough cognizance. Non-AI aspects such as API development. Infrastructure used for AI project and data protection measures have to be taken care of by a project lead.

6. Post release activities

A good AI team will not stop at deployment. Post release activities are equally important. Performance monitoring to quickly detect and fix minor issues, Continuous quality control to prevent the performance of your AI model from degrading and Regular retraining on new datasets to prevent model drift can attribute to right implementation and monitoring.

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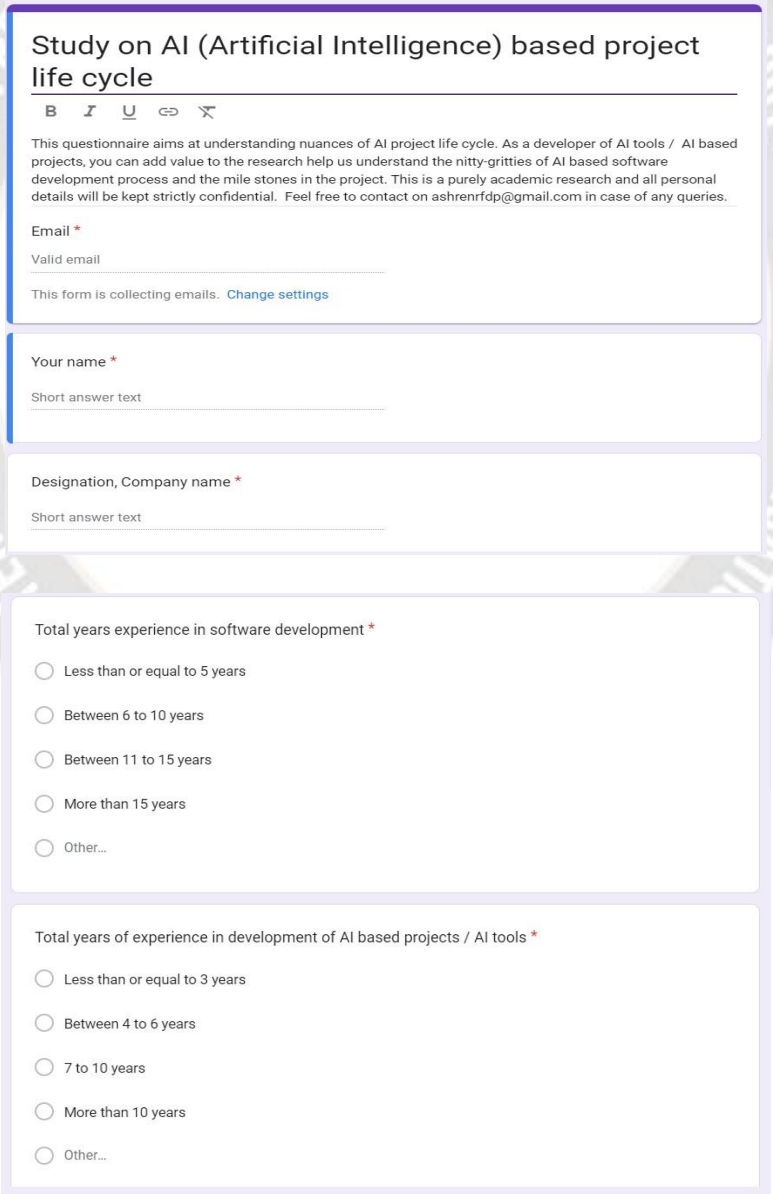
Annexure 1 – Questionnaire



Study on AI (Artificial Intelligence) based project life cycle

This questionnaire aims at understanding nuances of AI project life cycle. As a developer of AI tools / AI based projects, you can add value to the research help us understand the nitty-gritties of AI based software development process and the mile stones in the project. This is a purely academic research and all personal details will be kept strictly confidential. Feel free to contact on ashrenrfdp@gmail.com in case of any queries.

Email *

Valid email

This form is collecting emails. Change settings

Your name *

Short answer text

Designation, Company name *

Short answer text

Total years experience in software development *

- Less than or equal to 5 years
- Between 6 to 10 years
- Between 11 to 15 years
- More than 15 years
- Other...

Total years of experience in development of AI based projects / AI tools *

- Less than or equal to 3 years
- Between 4 to 6 years
- 7 to 10 years
- More than 10 years
- Other...

Your role in AI based projects *

- ○ Analyst
- ○ Developer
- ○ Model builder
- ○ Model tester
- ○ QA / Release
- ○ Other - Please mention
- ○ Other...

Do you follow standard "problem definition, model selection, adapt and align model, Application integration".as 4 major phases in the AI project life cycle? *

- ○ YES
- ○ NO
- ○ Other
- ○ If you follow some additional phases, please mention

Which standard algorithms / models you use most frequently that ensure the high quality of the product? *

Long answer text

What you feel are additional phases / activities that are important from AI project point of view and why *

Long answer text

Which, according to you are mile stones in an AI based project? *

Long answer text

What are critical success factors, according to you that affect AI based project life cycle and overall success of the product? *

Long answer text

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