

AI 어플리케이션 제작 계획에서 발생하는 어려움 및 해결 방법에 대한 이해

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Towards Understanding the Challenges and Remedies in AI Application Development Planning

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Abstract

Despite the growing demand for AI application development, many efforts fail to yield successful AI applications due to many difficulties that arise during the collaboration of various stakeholders. In this work, we specifically focus on the planning stage to identify the challenges that arise early on and remedies for the challenges that are utilized in the real world. Through a survey of 19 organizations that have developed AI applications, we find that AI development planning is a stage with an emphasis on AI-related contents and abundant information flow between stakeholders. This leads to challenges in communicating across knowledge barriers, making decisions around AI uncertainties, and keeping track of the overall planning process. Organizations cope with knowledge barriers by either circumventing the barriers, communicating through a mediator, or investing resources to remove the barrier; they navigate the AI uncertainties by investigating relevant AI applications, consulting AI experts, and experimenting with the AI technology; they track the planning process by using structured documentation. Based on the various strategies for coping with the challenges, we propose guidelines on how organizations can apply our findings to their AI application planning processes.

1. Introduction

The promise of AI technology has led many organizations in various domains to move towards incorporating AI into products, services or workflows. The shift towards building AI applications is expected to continue [1]. Despite the growing demand for AI application development, only about half of the AI projects reach completion and enter production [2]. The low success rate of the AI projects hints at the presence of unique challenges in AI application development.

Recent work identified the key sources of difficulties faced in AI application development: the complexity of the AI technology [1] and the intersection of the interdependence of the tasks of various stakeholders [3]. The findings led to various prototypes targeted at lowering the collaboration barrier by untangling the interdependence of the tasks [4, 5]. While these research efforts carry significant implications for the main development phase of AI application development, the efforts have only just started to travel upstream in the AI application development procedure to its first stage: planning.

Generally speaking, planning is a crucial step for determining the goals and means of the actions to be taken. The importance of planning is especially pronounced in projects involving a diversity of stakeholders; it is a process for coordinating various opinions and knowledge between stakeholders into a clear path forward [6]. It naturally follows that planning is a key step in AI application development, a process involving multiple stakeholders. Hence, organizations would be able to efficiently plan clear paths forward by understanding the impacts of stakeholder interdependence and complexity of AI technology in the planning stage.

Based on this motivation, this paper seeks to shed light on the

planning process in AI application development through a survey of 19 organizations. Specifically, we seek to identify challenges in AI application planning and compile how they are addressed in practice. We then discuss how the findings can guide future AI application planning efforts.

2. Related Work

Planning is a crucial step for determining the goals and means of achieving the goal [7]. Prior work in various domains shows that planning can significantly increase the effectiveness and performance of execution. Research specifically targeting AI application development processes has begun showing their acknowledgement of the importance of planning in AI application development. Subramonyam et al. specifically include planning as a separate step in AI application development during which AI engineers and designers set expectations about the capabilities of the final AI application [8]. Our work is motivated by the recognition of planning as a key stage in AI application planning and seeks to go a step further in scrutinizing the planning stage in isolation.

Because AI application development is a complicated process requiring a large number of decisions with multiple stakeholders, companies, and researchers have published various guidelines to help organizations through the process [9, 10]. While the guidelines cover a wide range of topics to consider in building AI applications, they provide general best practices on the overall process of AI application development without a specific focus on its collaborative nature. On the other hand, our work characterizes planning, identifies its challenges, and suggests solutions with a lens of collaboration.

* Equal contribution

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3. Methodology

Par.	Org.	Org. size	Prj. Domain
P1	O1	<10	Medical
P2	O2	1000-10000	Education
P3	O3	>10000	Data analytics
P4	O4	1000-10000	Audio / Creativity
P5	O5	>10000	Language
	O6	>10000	Productivity
P6	O7	100-1000	Finance
P7	O8	100-1000	Data annotation
P8	O9	10-100	Education
	O10	10-100	Medical
	O11	<10	Finance
P9	O12	<10	Video
	O13	1000-10000	Food production
P10	O14	100-10000	Advertisement
P11	O15	100-1000	Cartoon
P12	O16	100-1000	Education
P13	O17	10-100	Video / Commerce
P14	O18	10-100	Pharmaceutical
P15	O19	<10	Robotics, Dining

Table 1. List of participants and organizations we surveyed.

Because the planning stage has not been carefully studied in building AI applications, we conducted a semi-structured interview with 16 participants affiliated with 19 organizations to understand the process of planning as well as the challenges in the process and the ways the organizations cope with the challenges (Table 1). We used snowball sampling to recruit our participants and performed the interviews on Zoom. We specifically inquired about (1) stakeholders in planning and their roles, (2) procedures of planning, (3) contents of planning, and (4) challenges of planning and their mitigation strategies. After concluding the interviews, three authors first performed open coding [11] and finalized them into a single set of codes after collective discussions.

4. Results

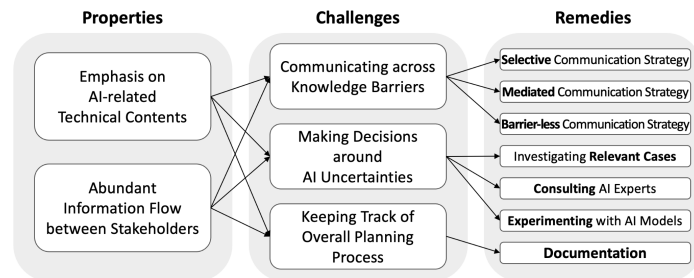


Figure 1. An overview of our results.

Figure 1 shows an overview of our results, showing (1) properties, (2) challenges, and (3) remedies of the AI application planning process.

4.1. Properties of AI Application Planning

The properties of AI application development that distinguish it from non-AI software development, namely the complexity of AI technology and the interdependence between stakeholders, uniquely shape the dynamics of participation in planning. In particular, we find that the complexity of the AI technology puts a heavy emphasis on AI expertise and the AI-related technical components during planning and that the interdependence between stakeholders results in abundant information flow between stakeholders.

4.1.1. Emphasis on AI-related Technical Contents

Technical approach and its feasibility, along with business feasibility, determine the scope of the application and whether the development would proceed. To deal with the demanding nature of technical

considerations around the AI component, AI engineers are often the ones initiating and leading the planning process. However, as a result of the empowerment of AI engineers and AI-related technical contents, we noted a general de-emphasis among the remaining stakeholders (i.e., domain experts, designers, and developers) and contents.

4.1.2. Abundant Information Flow between Stakeholders

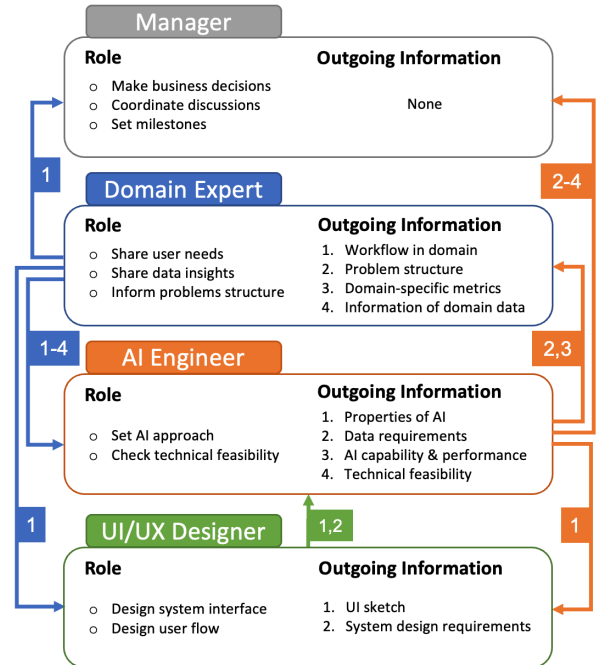


Figure 2. Each stakeholder's role and information flow.

Because AI application planning is a collaborative process between various stakeholders, they must work together closely and share information with each other during the planning stage. Figure 2 shows the information flow between the stakeholders.

4.2. Challenges & Remedies in AI Application Planning

The emphasis on AI-related technical content as well as the abundant information flow between the stakeholders lead to various challenges experienced during planning. And various organizations have come up with their own ways to cope with the challenges.

4.2.1. Communicating across Knowledge Barriers

Challenge. The specialization of the expertise involved in the process creates knowledge barriers when they communicate information. The large amount of information between the stakeholders renders the knowledge barrier a major problem experienced during planning. The most prominent knowledge barrier is around AI technology (O4, 5, 7-10, 13, 15, 17-19) as it sits at the core of all information flow and is a heavily specialized field. Specifically, non-AI experts have difficulties in communication because of a lack of awareness of AI-related terms including metrics (O2, 4, 8-9, 13, 18).

Remedies. We identified three strategies commonly used by organizations to handle knowledge barriers. First, the *selective communication strategy* circumvents the knowledge barrier by selectively communicating high-level key information to avoid complex contents (O5). Next, the *mediated communication strategy* takes advantage of a communication mediator who acts to bridge the stakeholders' communications (O2, 4, 8-10, 13, 17). Managers often act as communication facilitators as they often possess knowledge spanning across multiple expertise (O2, 8-9, 17). Finally, the *barrier-less communication strategy* requires an intensive investment of resources to remove the knowledge barrier to promote smooth communication (O6, 15) and is implemented through training the stakeholders through educational programs (O2, 4, 6, 9-10, 13, 19),

collaborative workshops (O4, 7), and regular invitations of other stakeholders to join stakeholder-internal meetings (O4, 7-8, 10).

4.2.2. Making Decisions around AI Uncertainties

Challenge. The planning stage of AI applications presents significant challenges due to uncertainties about the underlying AI model's behavior. Non-AI stakeholders often grapple with these uncertainties, which affect their decision-making processes and continue to pose challenges throughout the development phase. Specifically, it is not only difficult to form expectations about the performance of the AI model (O2-3, 9, 15) but also difficult to understand the errors in advance (O1) or the data needed for training the model (O14, 16, 17, 19). Consequently, it becomes challenging to design the user experience (O3, 8-9) and set reasonable targets for the application (O4). As a result, the involvement of both AI engineers and non-AI stakeholders could lead to a chicken-or-the-egg problem, where they deadlock on each other because both of the stakeholders need the decision from the other stakeholder to make their decisions (O17).

Remedies. Organizations navigate the AI uncertainties as much as possible for making decisions. Most of them begin by investigating similar or relevant AI applications (O2, 16, 19, 1, 4, 12). The organizations further navigate the space by consulting AI experts (O13, 18, 19) or experimenting with AI models beforehand (O1, 4, 11, 12). The dependency deadlocks between AI engineers and non-AI stakeholders are usually mediated by managers (O17).

4.2.3. Keeping Track of Overall Planning Process

Challenge. AI application planning is a complex process with not only numerous decision points requiring careful consideration, but also heavy interdependence between them; all stakeholders must remain up to date with the overall process. To begin with, the large number of considerations makes it challenging to keep track of all the planning decisions and understand whether the discussions covered most if not all the crucial considerations (O3, 5, 6, 16, 19). The difficulty of keeping track of planning decisions often leads to missing or insufficient discussion on major discussion points during planning, including error and transparency (O1), user experience (O2, 3), target users (O4), and data availability (O19). As a result, the organizations needed to revisit these discussions either during the development phase for major shifts in direction (O4, 19) or even after development completion for post-deployment patches (O1, 2, 18).

Remedies. A commonly used method for keeping track of the overall planning process is documentation (O2, 6, 9, 13-14, 16-19). Documentation includes sections such as a one-line summary (O6), the end goal (O6, 9, 14, 16, 18), expected benefits and impacts (O6, 9, 16-18), methodology and data/pipeline specifications (O6, 9, 14, 17-19), related work (O6, 19), user interface and flow (O9, 14), and milestones and timeline (O6, 9, 14, 16-19). Documentation helps guide discussions about the various considerations. It also helps keep the stakeholders up to date with the decisions (O6, 14).

5. Guidelines for AI Application Planning

The efficacy of communication and the amount of required resources differ for each strategy. The selective communication strategy does not require much resources, but merely circumvents the knowledge barrier, and is hence suitable for one-time consultations and not for longer-term collaboration. Contrastively, the mediated communication strategy is the most resource-intensive but allows seamless communication and is suitable for longer-term collaborations that may last beyond the current application development. The barrier-less communication strategy remains between the two other strategies both in terms of the required resources and efficacy of communication and is suitable for shorter-term collaborations. We note that an organization could begin with the selective communication strategy, focus their resources to move on to the mediated communication strategy, and eventually apply the barrier-less communication strategy.

Information about similar or relevant AI applications can come from various sources (e.g., academic papers, news articles, organizational reports) and can focus either on how existing AI technology is applied to a domain or on the technicalities of the AI technology. Organizations can obtain a holistic and coherent understanding of the intersection between AI technology and the domain by gathering sources across both axes and connecting the information. Consultation and experimentation can be especially helpful in linking the information back to the problem at hand.

The utility of documentation is maximized when information is presented in an easily readable and understandable form for the stakeholders. Specifically, definitions and explanations of terminology should be easily locatable to deal with knowledge barriers. In addition, due to the vastness and interconnectedness of information, linking between various relevant or dependent materials would greatly reduce the mental burden from trying to link separated ideas.

6. Conclusion and Future Work

In this paper, we seek to understand the process of planning in AI application development. Through interviews surveying planning practices for AI application developments, we find that planning is a collaborative process with an abundant amount of information flow with AI-related contents playing central roles. As a result of these properties, organizations face the challenges of communicating across knowledge barriers, making decisions around AI uncertainties, and keeping track of the overall planning process. Organizations remedy these challenges by applying various communication strategies, navigating the intersection of AI technology and the domain, and documenting the planning processes, respectively. We hope our guidelines for applying the remedies to AI application planning would spark further investigations into the planning stage and guide the development of assistive tools for streamlining the planning process.

References

- [1] Gartner. "Gartner Predicts The Future Of AI Technologies." Retrieved Apr 19, 2023 from <https://www.gartner.com/smarterwithgartner/gartner-predicts-the-future-of-ai-technologies>. 2019.
- [2] Gartner. "Gartner Identifies the Top Strategic Technology Trends for 2021." Retrieved Apr 19, 2023 from <https://www.gartner.com/en/newsroom/press-releases/2020-10-19-gartner-identifies-the-top-strategic-technology-trends-for-2021>. 2020.
- [3] Delgado, Fernando et al. "Stakeholder Participation in AI: Beyond 'Add Diverse Stakeholders and Stir'", *arXiv preprint arXiv:2111.01122*, 2021.
- [4] Françoise, Jules et al. "Marcelle: composing interactive machine learning workflows and interfaces." In *The 34th Annual ACM Symposium on User Interface Software and Technology*, pp. 39-53, 2021.
- [5] Subramonyam, Hariharan et al. "Protoai: Model-informed prototyping for ai-powered interfaces." In *26th International Conference on Intelligent User Interfaces*, pp. 48-58. 2021.
- [6] Dingsøy, Torgeir et al. "Coordinating knowledge work in multiteam programs: Findings from a large-scale agile development program." *Project Management Journal* Vol 49, No. 6, pp. 64-77, 2018.
- [7] Levy, C. Michael, and Sarah Ransdell. *The science of writing: Theories, methods, individual differences and applications*. Routledge, 2013.
- [8] Subramonyam, Hariharan et al. "Towards a process model for co-creating AI experiences." In *Designing Interactive Systems Conference 2021*, pp. 1529-1543. 2021.
- [9] Amershi, Saleema et al. "Guidelines for human-AI interaction." In *Proceedings of the 2019 chi conference on human factors in computing systems*, pp. 1-13, 2019.
- [10] Google. "Google People + AI Guidebook." Retrieved Apr 19, 2023 from <https://pair.withgoogle.com/guidebook/>, 2019.
- [11] Khandkar, Shahedul Huq. "Open coding." *University of Calgary*, 23, 2009.