

Standard Development for Improvement of Stakeholder Communication for Design Projects in Architecture, Engineering, and Construction Industry Deploying Clean Energy Solutions

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Abstract

Projects in the architectural, engineering, and construction (AEC) industry are heavily driven by strict timelines and budgets. Typically, design engineering firms handle a large volume and wide variety of projects, thereby requiring both competent professionals and resources to deliver high-quality products and services. The industry would grow to USD 26.79 billion by 2034, which initiates the need to address current gaps, especially in communication between stakeholders and project delivery teams. Almost every project manager is committed to completing the project on time and on budget. Given the nature of the project, it may often have either a start and end date or success or failure. Due to varying practices across virtual and in-person work settings, AEC projects require careful consideration to distinguish project communication based on project budget, criticality, and stakeholder types. This research addresses the communication gap by documenting the types of projects, the size of team members, and the impact of communication on project deliverables using conceptual modelling. Therefore, a framework for training and Artificial Intelligence (AI) using AEC projects across the United States becomes a standardization process for shaping the future of clean energy-driven projects aligned to the three pillars of sustainable development. The model projects improvement in project delivery across both schedule and budget. This framework may scale up to cover a wide range of project management services for engineering projects in infrastructure development for both private and public facilities worldwide.

Keywords: Project communication, architecture, engineering, construction (AEC), clean energy, project stakeholders

INTRODUCTION

Project managers require a high level of competence, both from practical knowledge and experience over time. Several project managers have devised methods for developing long-term relationships with stakeholders [1]. They, with their communication and management styles, can meet the project's needs and deliver the project's deliverables without much hassle from stakeholders. First, let us understand how stakeholders react to the project manager regarding the communication provided to them. When a difficult stakeholder is encountered, the project manager must first recognize that the concerned person or group is difficult. After identifying difficult stakeholders, the project manager must determine where they stand in terms of power, knowledge, and influence. The greater the power, the more the project manager's role in keeping them engaged throughout the project delivery process.

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Some of the major aspects that a project manager must learn include having a conversation as early as possible with each type of stakeholder. For example, before the start of software development, they must reach out to conduct a general survey with important customer stakeholders [2]. Get their feedback on the scope of work. Some mistakes can be avoided by knowing what the product should look like and being free of deficiencies that were previously known to the stakeholders. It is possible to explore some information that would be very useful for the project to have a streamlined flow and product.

Another aspect is to keep the communication channels open with all stakeholders. For example, if a particular stakeholder prefers to be called and informed of progress, the project manager must ensure that this happens every time they inform by phone and not use any other means that were not preferred by the customer or stakeholders. Feedback from them after regular conversations is crucial. Conveying messages acknowledging stakeholders' responses is another way to build confidence and trust in the process.

As communication channels can be any, ranging from email to phone to virtual meetings with or without video, the best method should be known to the stakeholders before use. In some cases, virtual meeting methods can result in data breaches when many stakeholders are not present. However, this could be the best way to reach out to them, as it can be more convenient for them, as they do not have to show up in person [1]. However, it is known that in-person meetings are more impactful and help build good relationships. For example, a project kick-off meeting to define the scope of work can attract more staff members and stakeholders. The person in touch with the members is a very effective way for a project manager to ask questions in the future and have them clarified.

In this study, we focus on how well a project manager can devise plans to handle known stakeholders and those that are unknown and may randomly show up at any phase. Each type of stakeholder requires certain methods of handling. For example, a stakeholder from a government agency would require more formal notifications via written memos, whereas some private stakeholders would require both written memos and presentations to be informed. Therefore, the project manager must know how to tackle them and mitigate any adverse effects caused by improper communication methods. Matrices are sometimes developed to list stakeholders, including their contact information and preferred communication methods. It is good practice to learn from each stakeholder beforehand how they would like the communications to look like. For example, whether they would like meetings quite often or at each milestone. Some project milestones may be critical, whereas others may not be critical to stakeholders. For example, creating an efficient software code or making changes to it may not require many stakeholders to be informed, as they do not change the project's outcome or user interface, which may have greater implications for a large portion of stakeholders.

The purpose of this research is to establish ways to make stakeholder communication as effective as possible and devise the right methodology for communicating with the type of stakeholder in question. When a project manager learns which stakeholders are important and hold the most power, they can focus on them. Improving communication methods is another aspect of this study. An approach for project managers was presented to help them find the stakeholder satisfaction level to the best of their ability. In the architecture, engineering, and construction industries, projects categorized by team member volume and type can indicate the criticality of communication between teams. The budget savings and enhanced completion timelines of this project are aligned with the principles of sustainable development when deploying clean energy solutions.

When we say that communication is required between project teams and stakeholders, a part of purposefulness is required. The authors believe that communication should be purposeful [3]. Potential tensions have risen because communication with stakeholders is a learning process that should be minimized [4]. Adaptation to the right communication during a given situation is another aspect that a project manager must learn [5]. The authors focus on a unique way of seeing things when they argue

that project managers must understand some aspects of stakeholders' knowledge [6]. For example, the terminology used in project management may be well known to stakeholders. There is also insufficient evidence to determine what those terminologies are or whether they are difficult for stakeholders [6].

In AEC projects, the terminology used can be challenging for project stakeholders to understand. This is important to learn as the practical application in the construction industry project is studied. The authors conducted many surveys to determine which terms, such as the iron triangle, critical path, and those related to uncertainty, were difficult for stakeholders to understand [6]. Using the right jargon with project stakeholders is key to successful communication, as it can avoid confusion. In the AEC industry [7, 8], the importance of BIM systems and barriers in the Australian economy provide insights into how BIM models can be utilized for training AI models, and lessons learned from practical applications in the global economy can be scaled.

Another aspect of looking at things is the stakeholders' education levels. Some stakeholders may have a different background altogether. For example, some electricians with years of experience have transitioned into managerial roles. Due to a lack of formal project management training, they might not know the jargon, but they can manage the work they are supposed to perform very well. The project manager must understand this and use the right jargon when talking to them. People who do more hands-on work may not be familiar with theoretical or technological terms, which can leave them out of the loop during important meetings. The lasting effect of clear and precise communication must be explored and used by project managers [4]. Additionally, the existing literature [9, 10] has reasonably presented the growing AEC industry with sustainable energy initiatives. A methodology driven by streamlining project management promises solutions for sustainable development, especially the third pillar of the economy.

METHODS AND PRACTICAL APPLICATION

A simple, practical application is what we are applying to the project that involves the development of a residential building in a neighborhood. The project manager begins by listing the stakeholders at the beginning of the project. For example, the known stakeholders include residents, developers, architects, engineering contractors, environmental authorities, local state or federal government officials, building construction materials providers, owners or owners' representatives, and local construction standards enforcement agencies.

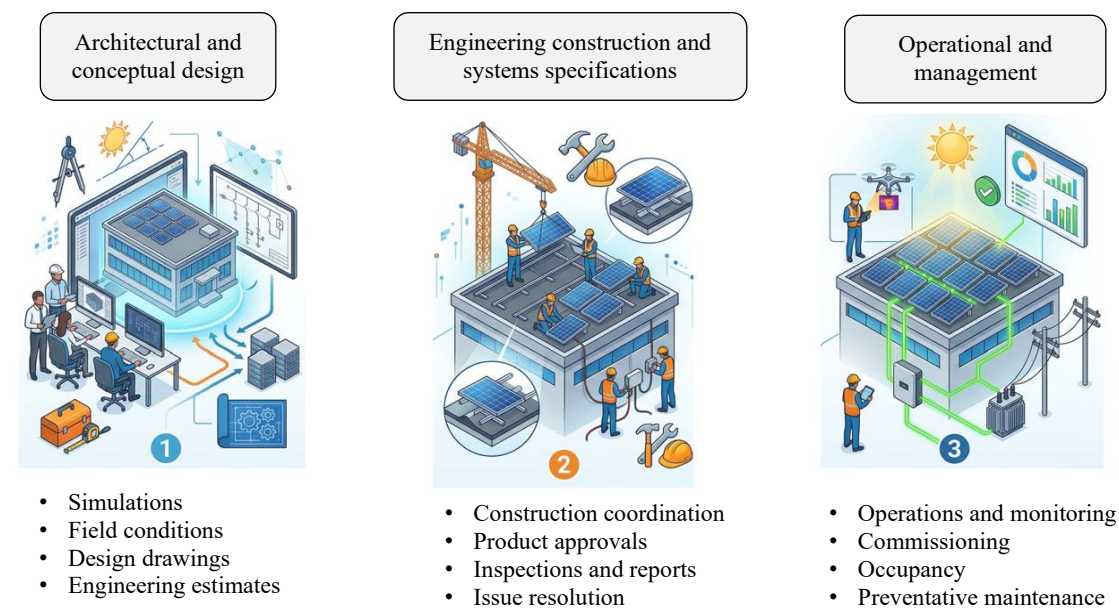
The project manager must start jotting down the list of stakeholders and prepare a list of nuisance stakeholders. During the project kick-off meeting, all stakeholders must be invited, the scope of work must be outlined, and feedback must be requested on any items that are unknown or require attention at the scoping level. Once this information is known, the project manager must develop a matrix listing the contact information and preferred methods of communication, along with their frequency. Additionally, knowing the right communication methods can help them easily develop a long-standing relationship. For example, making phone calls to the owner or the owner's representatives and updating them on daily progress could significantly improve the long-standing relationship.

Having learned that not every stakeholder is a real stakeholder, the project manager can avoid delays in construction work. For example, a certain building material provider suddenly shows up with issues related to non-payment of services. Instead of the project manager starting to investigate why a party is not being paid, they can look up the list of stakeholders and reject it. However, whether they turn out to be phantom stakeholders is another question. An experienced stakeholder can easily identify whether a stakeholder is a phantom.

When creating project milestones, the project manager has an excellent opportunity to present the project deliverables to stakeholders and back-check whether any items are missed at the given stage.

Table 1. Project criticality matrix.

Project type	Typical budget (USD)	Team size (Approx.)	Communication criticality	Primary stakeholders
Utility-Scale Solar (PV)	\$50M–\$250M	100–300	High	Utilities, Landowners, EPC, Local Gov
Onshore Wind Farm	\$100M–\$500M	150–400	High	FAA, Wildlife Services, Landowners, Grid Ops
Offshore Wind Farm	\$1B–\$5B+	500–1500	Extreme	Marine Auth, Port Ops, Investors, Tech Vendors
Battery Energy Storage (BESS)	\$20M–\$150M	40–100	Moderate-High	Fire Marshals, Grid Operators, Software Devs
Green Hydrogen Facility	\$100M–\$1B+	200–600	Extreme	Chemical Engineers, Off-takers, Logistics, DOE
EV Charging Infrastructure (DCFC)	\$1M–\$25M	20–60	Moderate	Retail Property Owners, Municipalities, Utilities
Microgrid System	\$5M–\$50M	30–80	High	End-users, Tech Integrators, Local Utilities

**Figure 1.** Clean energy AEC project.

For example, a design development drawing could include important milestones before construction, such as 30% to 90% design, which is reviewed by all stakeholders before proceeding to a 100% design. Avoiding mistakes and learning from them is another tool that project managers can devise. Some learning can come from past projects, but much can come from the project itself.

In the U.S. Architecture, Engineering, and Construction (AEC) sector, clean energy projects are characterized by high technical complexity and a dense network of stakeholders (utilities, government agencies, EPC contractors, and technology vendors). Effective communication is not only a soft skill but also a critical driver of project performance. Table 1 shows the project criticality matrix documenting the nature of criticality in communications (moderate and high criticality). Figure 1 shows the process of clean energy project execution for a rooftop solar photovoltaic system project.

STANDARDS DEVELOPMENT PROCESS

The standards development process leverages the input from Table 1 and begins adding possible input data for AEC projects and preparing a framework, as shown in Figure 2. Starting from BIM models, schedules, budgets, cost estimates for design and construction, existing conditions documentation

from reports and field sensors, and communications from stakeholders, this data is processed via a central AI hub that delivers and monitors the overall effectiveness of the project in meeting stakeholders' expectations. Several researchers [11–13] have developed AI frameworks for human–machine interfaces, SWOT analysis, and developing analyzed results from trends in the AEC industry. However, some authors [14, 15] have enabled data collection for AI implementation. Therefore, this study further investigates AEC projects with waterfall models. The typical waterfall model has been considered for this approach to standards development. However, the Project Management Institute (PMI) provides guidelines for communication plans. This study presents a practical, field-related solution for clean energy projects in the AEC industry. Communication with stakeholders is very important, and the best way for a project manager to deploy communication tools is what they should focus on. Starting with the media available, email lies at the lower end and in-person communication at the upper end. With the world going virtual in most workplaces, there are more virtual meetings, with or without videos. It is more promising when a video is enabled than when it is not enabled. Similarly, phone calls were placed after the emails and before the virtual meetings. The greatest advantage of an in-person meeting is that all types of communication means, such as verbal, non-verbal, written, visual, and experiential, can be used. Whereas with virtual video, there are partial non-verbal means of communication, and so is the experiential. When virtual with audio is enabled, there is vocal-only non-verbal communication with the selection of tone or voice gestures. In phone calls, there is a gain in vocal non-verbal communication, with partial experience. Writing does not involve verbal or non-verbal communication. Given that in-person meetings are the top preference, project managers must organize in-person meetings with stakeholders, as they get to know each other and a stronger relationship develops. There are risks associated with virtual meetings, such as technology issues, and there could be leaks of confidential information when organizing meetings. They can be accessed by hackers and misused. However, virtual meetings can also result in some members not attending because of connectivity issues or other technical problems. For instance, a recent Microsoft outage affected many industries that used its products. Additionally, when virtual meetings are held, some members may lack attention and show less interest in the proceedings. They might answer only the questions asked, ignoring the critical information that stakeholders need to know.

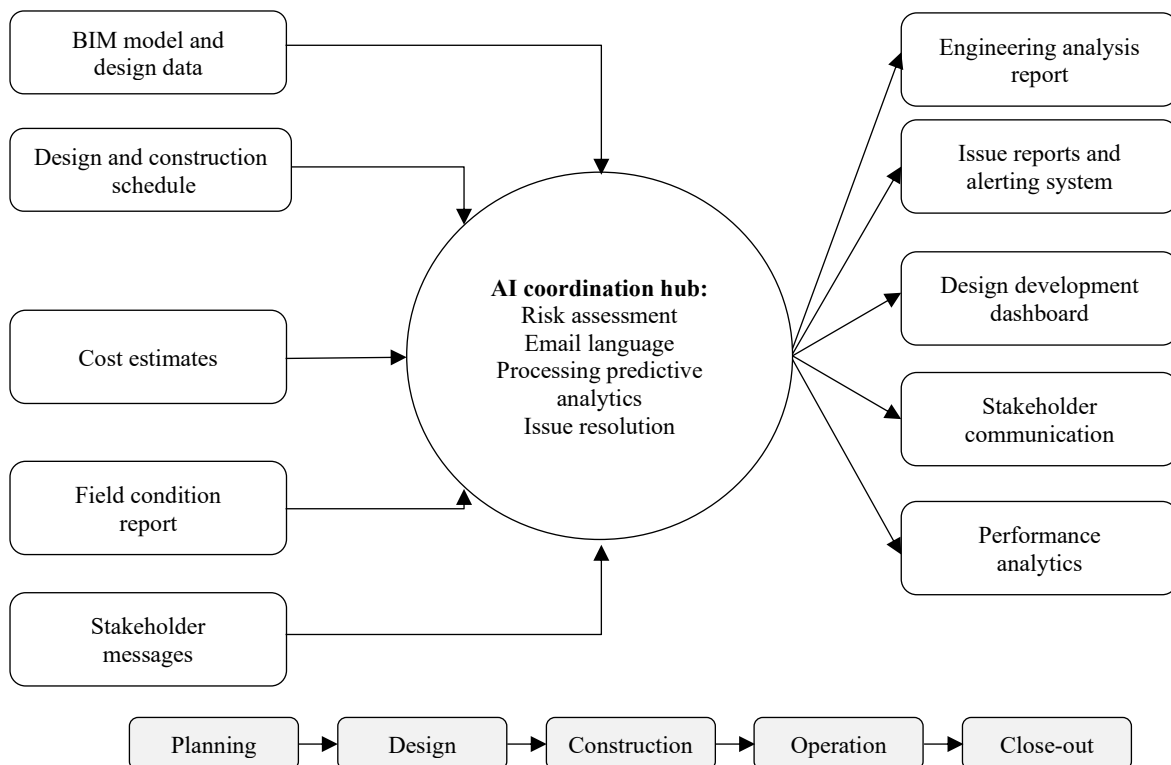


Figure 2. Artificial intelligence framework development.

However, one should not always resort to in-person meetings, as there are potential risks. This study aims to address the communication gap arising from language barriers. They could be cultural differences, so a certain gesture might be mistaken for something else.

There are multiple risks associated with virtual meetings, starting with technological failures. Certain virtual meeting tools may experience outages due to cyberattacks or service provider outages. There are time zone differences that can cause issues with virtual meetings; some members may attend while others may not. It is also possible that some members are in the evening time zone, while the rest are in the morning. Those in the evening time zones would be less interested as they are ready to run home towards the end of their work hours, and vice versa. There are many distractions during virtual meetings. For instance, a person may be on another phone call during a meeting. The project manager believed that all project stakeholders had received the message, but in reality, some barely heard the project manager's words due to the noise. Another major challenge is local laws and regulations that restrict certain communication channels.

An experienced project manager can handle a difficult stakeholder using their experience. First, the project manager should understand the cause of the difficulty. Please try to minimize this first. Second, the project manager should be empathetic toward the stakeholders, understand their basic problems or concerns, and address them immediately. Third, the project sponsor may be engaged. Fourth, prepare a plan to address the issues of difficult stakeholders. Start by scheduling more meetings to see where the project manager stands regarding the expectations of the difficult stakeholder. The plan is deployed and monitored as the project moves towards the outcome.

The role of the project manager in determining executive stakeholders and establishing a method for communicating with them is something that is great to learn from this week's reading. The types of executive stakeholders range from customers and executive sponsors to the executive council and supplemental executives. The idea behind communicating with them is to use a language they are used to hearing. For example, a project progress status showing a delayed project due to a technical issue would not be understandable to someone without a technical background at the executive level. Therefore, the project manager should convert the information from project language to executive language.

Customers are critical to the project's progress as they are the users. The customer plays a major role in defining the project's goals, and documenting their requirements ensures that project managers can track the project. An executive sponsor is a senior advocate crucial to the project's success, as they are the project's major stakeholders. The executive council serves as a guidance provider and is composed of groups of eight to 16 members. Any other executives other than the previously defined customers, executive sponsors, and councils are supplemental. Communication is key to project management, and as project managers begin to engage executive stakeholders, they improve their communication. For example, executives like to hear from project managers about ongoing projects. A timely status update ensures that they are in the loop and not left behind at crucial stages of the project. Most importantly, customers must be informed to build a healthy relationship. Sometimes, many executive stakeholders remain silent for a while but then start communicating with the project manager, asking why things are not as requested. This is when the project manager must be proactive and keep them informed as the project progresses, so that in the future, there are no complaints that executives were not informed about the project development phases.

Communication with executives is slightly different, as the project manager should use terms they are familiar with. Communication starts with verbal communication. Verbal communication can occur through phone calls, conference calls, and so on. The advantage of verbal communication is that it enables human interaction, leaving an impact that an email would not. Moreover, during the call, answers can be requested and a good relationship can be developed. Although there are drawbacks to these communications, key members are absent on many conference calls. Sometimes, during verbal communication, many team members answer but later forget.

Non-verbal communication is via expressions or body language, which many project managers develop and use with experience as they start to interact with stakeholders in person. A major challenge with these communications is that they are merely expressive and cannot be documented; however, they help the project manager understand the stakeholders' psychology. Written emails or charts are effective methods for communicating with stakeholders. Some people see graphs and pictures and relate to them well, whereas others prefer descriptive reports to understand project progress. Some experiential means include using case studies to communicate with clients. No means is good or bad for a project manager when communicating with executive stakeholders; it is just the experience they need to ensure that their messages are clearly communicated.

The choice of stakeholder communication channels depends on how well they are received by the targeted stakeholders. Let us begin with the available channels: verbal, nonverbal, written, visual and experiential. All these channels are useful for meeting the project's and stakeholders' expectations. The verbal channel mainly includes talking on the phone and organizing conference meetings, both remotely and in-person. For example, in a large infrastructure development project, several meetings are held via Microsoft Teams, and the project's aspects are presented. Nonverbal communication is more gesture-oriented, with messages conveyed through body language and facial expression. For example, raised eyebrows can indicate concern, whereas a smile can convey a comforting tone.

Written methods include emails, phone texts, group chats, and PowerPoint presentations. For example, some stakeholders prefer text messages to update them on meeting progress, and many project managers use emails followed by phone calls to reinforce the progress conveyed by emails. Visuals primarily focus on creating compelling charts, figures and images to convey the message. For example, several meetings include pie charts and bar graphs to showcase the impact of certain processes on costs, and stakeholders can relate to these. Experientials are mainly based on case studies and training sessions. For example, some analyses of case studies of similar projects are presented to stakeholders, which allows the project manager to be research-oriented and thus supports any argument that would otherwise be seen as less promising to stakeholders. Therefore, it depends on the project manager which channel they would use to be more impactful when communicating with stakeholders. Most likely, there are cases when some stakeholders would complain about the communication channel, so the project manager must start learning as they progress.

A phantom stakeholder is not formally identified by the project manager when listing stakeholders. They can impact the project's future but are not necessarily involved in decision-making. Some examples include a governing body from the environmental division that can have an impact when a project is completed. Similarly, some members of the public can be impacted by the project when the product is launched. Random stakeholders can be mistaken for phantoms. Phantoms could possibly have an impact in the future, whereas random stakeholders do not. Some random stakeholders would show up just to take advantage of the situation or get media attention.

There are instances when random people try to influence project deliverables, but the project manager should know who the real and phantom stakeholders are. After meeting the stakeholders, the project manager can easily ignore the nuisance caused by random people. The project manager is involved in customer satisfaction, but at the same time, they have control and authority over how to manage the project. They must face criticism, but as long as the project manager understands the power of each stakeholder, they can effectively manage their interests.

Let us consider an example of a project in which a small improvement to the building façade and parking area is being made. There could be potential stakeholders from the environment and the general public that the project manager should address. However, some random stakeholders from the public can start interfering with the project's development, claiming that there is an impact on local tourism due to the building redevelopment. As long as it is known that the building does not interfere with the

city's tourism, these random stakeholders must be ignored. More powerful stakeholders, such as city representatives, must be heard and addressed rather than random ones. Therefore, the project manager should know who the real stakeholders are and address any issues with them first, rather than being affected by random stakeholders.

CONCLUSION

An approach is presented in this paper for how project managers can identify the real stakeholders by starting off early, using the right way to develop project milestones, and thus conveying messages to each stakeholder during the milestone stage. Getting feedback, learning from ongoing project phases, and using the right method of communication are other tools that were identified for the project manager. Finally, the phantom stakeholder's preparedness is another aspect that an experienced project manager can handle. Selecting jargon and understanding how difficult it could be for some stakeholders is very important for project management professionals. With known aspects of the complexity in the terminologies, it is possible to avoid them many times to make the conversation very clear and precise for the stakeholders. Using a practical case study of the United States AEC industry in clean energy, a criticality matrix was developed to identify communication criticality. Furthermore, an AI standards development process was laid out, offering enhanced communications within projects worth millions to billions of USD.

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