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Future Opportunities for Stakeholder Management in Construction Projects

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One of the main factors determining project success is the satisfaction of its stakeholders, although it is rarely mentioned in scientific research. When the stakeholder's needs are not met, there can be significant downfalls such as delays in delivery times, extra costs, and unsuccessful project outcomes. By improving stakeholder management, project success can be increased. There still is a lack of attention and research in this area and the limited research in this area is fragmented. The research usually focuses on case studies of a specific project by mapping its stakeholders or discussing the method of stakeholder management used in the project. Also, it has been observed that current technologies and opportunities for digitalization are not being actively used to improve stakeholder management. This study aims to bring together all this fragmented scientific research by analyzing and categorizing existing methods, defining current barriers, and making future suggestions for a holistic view of stakeholder management since unsatisfactory stakeholder management can negatively affect projects and result in project failures. With this purpose in mind, this paper initially creates a summary of current methods used in stakeholder management and discusses their limitations. In the second portion of this paper, future trends in stakeholder management are discussed. Improving stakeholder management would result in more successful projects, this could only be done by keeping up with up-to-date methodologies, following future trends, and taking advantage of current technologies which would be discussed in more detail in this paper.

Keywords: Big data technologies, Building information modeling, Digitalization, Industry 4.0, Social network analysis

Introduction

In any construction project, there will always be various stakeholders. Stakeholders make up a significant part of the construction project. Stakeholders can be defined as "a person or an organization actively involved in the project or having an interest in or conflict of interest with the project execution or the project result".[1] The successful involvement of stakeholders in the whole building lifecycle – starting from initiation, to construction, all the way to demolition – adds to the overall project success. Thus, effective collaboration among the diverse stakeholders involved is essential for the success of construction projects, leading to the need for studies that focus on stakeholders' perspectives in construction projects.[2] However, just discussing successful stakeholder involvement is not enough. When there is more than one stakeholder involved in the building project, the relationship in-between stakeholders has to be managed. The stakeholders and their relationships in a construction project are like a complex spider web. Since construction projects have many stakeholders who are from very different backgrounds, stakeholder management becomes of uttermost importance. If not managed carefully and successfully, stakeholders' inner relationships can be harmful to the project's outcomes. To have successful stakeholder management, one has to know their stakeholders, their motives, and their expectations. The relationship between all stakeholders should be transparent and accessible. Knowing the stakeholders' expectations clearly would determine the overall project's success.[3] Stakeholder opposition is "one of the main and less predictable, risks of construction projects. It can raise a project's costs by delaying the project, leading to reputation damage of project developers, and increasing the possibility that the project is canceled".[4] Thus, one of the main factors in successful project management has been stakeholder management.

The construction projects are highly complex and uncertain, which makes Stakeholder Management difficult. However, "stakeholder involvement is important to project outcomes, and recognition of the concept of stakeholder management is growing".[5] Over the years, project managers have tried various methods to improve stakeholder management. However, there

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seems to be a gap in the area of stakeholder management which causes unsuccessful projects. Unsuccessful projects can be defined as projects that are over budget, projects that cannot meet the predefined schedule, and projects with unsatisfied team members and/or clients. Although some project managers understand the importance of Stakeholder Management, the lack of scientific research and structured systems in this area causes the adoption of inadequate methods.[5,6] During the scientific literature research done for this paper, it was realized that there is very limited and fragmented scientific research in the field of Stakeholder Management. There is almost no research discussing the issue in a holistic way and summarizing the current situation in this field.

Construction projects have grown in size and gotten more complicated in today's world. In addition to this many other factors have made stakeholder management more challenging as well as more crucial such as stakeholder numbers have also grown substantially, projects today are internationally designed and constructed, and end-users have more sophisticated and complicated demands. With today's developing technologies the complicated nature of stakeholder management in construction can be easily facilitated. In the final portion of this paper, future directions for stakeholder management will be discussed, hoping to ensure stakeholder satisfaction, resulting in more successful projects. Also, it was realized that almost none of the current technologies and digitalization opportunities were used for Stakeholder Management. Realizing this gap, this paper will define the limitations of current stakeholder management methods and discuss possible solutions and future directions. In order to do so, the following steps will be followed:

1. Outlining the current situation in stakeholder management from scientific literature research,
2. Categorizing the current models and methods in use for stakeholder management,
3. Detect and organize the current barriers faced in stakeholder management,
4. Defining ways to improve stakeholder management,
5. Defining the future directions stakeholder management can go.

Methodology

A literature study was conducted for the purposes defined above. The methodology for this will be explained in the following steps.

- As can be seen in Table 1, the following keywords were used in the query string, including: "construction management" AND "stakeholder management" OR "stakeholder relationships" OR "stakeholder influence" OR "stakeholder engagement" OR "stakeholder mapping" OR "stakeholder models". These keywords in the title/abstract/keyword/text fields were searched to find all related publications.
- Although there might be the mention of "stakeholder management" in the text, the paper might be about something entirely different. So instead of searching "stakeholder management" keywords like "stakeholder influence", "stakeholder relationships", "stakeholder mapping", "stakeholder engagement", and "stakeholder models" gave more accurate results.
- As can be seen in Table 1, this initial search identified 391 journal articles published within an unlimited time frame in English in Science Direct (Elsevier Journals), Scopus and Web of Science.
- As can be seen in Table 2, irrelevant articles to the topic of this research and duplicates were

Table 1 — Keyword search

Keywords	Number of articles
"construction management" and " stakeholder management"	172
"construction management" and "stakeholder engagement"	102
"construction management" and "stakeholder influence"	43
"construction management" and "stakeholder relationships"	52
"construction management" and "stakeholder mapping"	12
"construction management" and "stakeholder models"	10
Total Number Of Articles	391

Table 2 — Reasons for elimination

Reasons for elimination	Number of articles
• Duplicates of papers appeared in multiple searches and were therefore eliminated.	153
• There might be the mention of "construction management" in the text of the article but the article would be about another industry.	78
• Papers had one of these keywords in their list of references but not in the actual text.	52
• There might be an example in the text of the article related to "stakeholder management" but the article would be about another topic.	31
• Some papers with the keyword combination "construction management" and "stakeholder management" were listing project management areas and were not directly related to stakeholder management.	19
Total number of articles	391
Total number of eliminated articles	333
After evaluation & elimination	58

determined by carefully reading their title/abstract/keywords and were removed during further screening. The most significant reasons for the elimination of articles can be listed as such:

1. Duplicates of papers appeared in multiple searches and were therefore eliminated. Number of eliminated papers: 153
2. There might be the mention of "construction management" in the text of the article but the article would be about another industry. Number of eliminated papers: 78
3. Papers had one of these keywords in their list of references but not in the actual text. Number of eliminated papers: 52
4. There might be an example in the text of the article related to "stakeholder management" but the article would be about another topic. Number of eliminated papers: 31
5. Some papers with the keyword combination "construction management" and "stakeholder management" were listing project management areas and were not directly related to stakeholder management. Number of eliminated papers: 19

- Finally, a total of 58 articles were selected for a detailed analysis. In Tables 1 & 2, the details of the keyword search are presented.
- It can be seen from Table 3 & Fig. 1, that the first research encountered on this subject was published in 2005 and most of the research about stakeholder management come after 2010. About 90% of the research papers are published between 2011 and 2023 and 71% of the research papers are between 2016 and 2023. This might be because although people were starting to pay attention to project management and construction management to make projects more profitable for a long time, the importance and the influence of stakeholder management have been paid less attention to. It is just being recognized over the last few years how critical it is to have stakeholders more involved, well connected, and satisfied to have successful project outcomes.

Table 3 — Frequency of publications per year

Publication year	# of publications	%
2000–2010	5	8.6%
2011–2015	11	18.9%
2016–2023	41	70.6%
2011–2023	52	89.6%

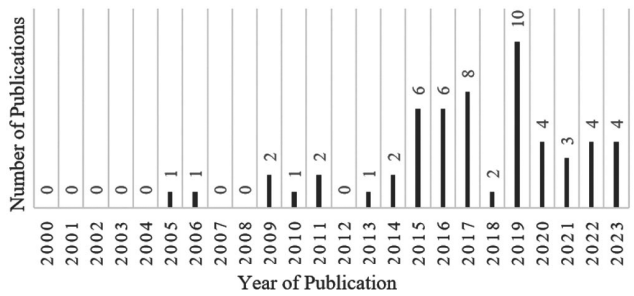

Fig. 1 — Year wise number of publications

Results

Stakeholder Management in Construction Projects

Once it was realized that stakeholder management has a serious influence on the success of construction project management, different management methods were experimented with to find the best one possible. In this portion of this paper, the stakeholder management methods encountered in the scientific literature research will be discussed.

Several steps have to be taken for successful stakeholder management. Project Management Book of Knowledge 6th edition[7] suggests that one should identify stakeholders, plan stakeholder engagement, manage stakeholder engagement and monitor stakeholder engagement. Successful stakeholder management has three main steps. These are identifying the stakeholders, examining the circumstances that stakeholders are in, and deciding on different strategies to manage stakeholders.[8] Other research has similar steps to identifying and prioritizing stakeholders and, but concludes by suggesting that a stakeholder engagement strategy should be developed.[9] Going over all research it was recognized that, stakeholders should be properly *identified, analyzed*, and then later *managed* with a proper strategy.

- "Stakeholder Identification" is the process of gathering information about stakeholders' interests, participation, interdependence, influence, and potential impact. This step is important because it defines which group of stakeholders to focus on according to the needs of the project.[7]
- "Stakeholder Analysis" is the next step to be taken after identifying stakeholders. This is crucial because it results in information such as a stakeholder's position in the organization, the stakeholder's role in the project, and most

importantly stakeholder's attitudes, expectations, and interests.[7] Understanding and analyzing stakeholders is what really decides which methodology should be used for Stakeholder Management.

- "Stakeholder Management" is defining and applying a stakeholder management strategy that outlines what actions should be taken, when they should be taken, if there will be a certain methodology used as a guide, and if there will be a professional responsible for stakeholder management, etc. However, in any stakeholder management strategy, there are factors influencing the overall Stakeholder Management success. Good communication with and between stakeholders, and having common objectives, goals, and priorities are the two main factors determining success.[10] As well, this list can be extended by communicating benefits and negative impacts, analyzing stakeholder needs and concerns, project organization, determining and evaluating alternate solutions, and media relations.[10] To summarize the views of the previous research, understanding and satisfying the needs of the stakeholder is the key to project success. Although the success factors vary according to the specific construction project, "good communication" can be found in almost all research related to stakeholder management.

Methods used for Stakeholder Management in Construction Projects

According to the 58 papers reviewed for this study, to achieve successful stakeholder management different methods, models and technologies have been used. The information found in the scientific literature review was very scattered and unorganized.

- Some of the studies didn't mention the use of any stakeholder management method whereas some suggested the use of multiple ones.
- Some of the studies only considered a limited number of stakeholders or stakeholder groups and did not include all stakeholders.
- The projects mentioned in the studies were from different countries and varied in size/function/participants.
- Although some of the technologies used are not specifically made for stakeholder management, they have been used for this purpose.

So, to have a more structured approach all different methods, models, and technologies encountered in this scientific literature review were grouped in 7 categories for the purposes of this study. As can be seen in Table 4, the most commonly used methods for Stakeholder Management in Construction Projects were the Power-Interest Matrix, Building Information Modeling (BIM), mapping based on network theory using Social Network Analysis (SNA), models using Design Structure Matrix (DSM), and/or Dependency Mapping Matrix (DMM), methods using Integrated Project Delivery (IPD) and various methods of stakeholder mapping.

Some of the above mentioned methods are older, more traditional and are conducted manually such as the Power-Interest Matrix or arrow diagrams, spider web graphs, etc. Some of the other methods such as BIM, SNA, and DSM are more innovative and depend on up-to-date technologies. According to the literature reviewed, these innovative models are not only used to better stakeholder management, but also facilitate all project processes.

***No Model/Technology/Method used*:** 27.5% of research articles based on stakeholder management did not mention the use of a structured stakeholder management model and/or the use of an up-to-date stakeholder management technology. This shows us that there is still a gap regarding the use of stakeholder management models/technologies. Stakeholder management is mostly seen as one of the less crucial factors and not paid as much as attention to as cost, schedule, quality management, etc.

***Network-theory and/or Social Network Analysis (SNA)*:** In the scope of this scientific literature review, the most commonly used method for stakeholder management was network-theory and/or social network analysis

Table 4 — Stakeholder management methodologies used in construction projects according to the reviewed literature

Method Used	Number of use
• No model / tech / method used	16/58
• Network-theory and/or social network analysis (SNA)	14/58
• Various methods of stakeholder mapping (tree graphs, arrow diagrams, spider webs, Q method, text mining, comparison graphs, collaboration framework, etc.)	11/58
• Building Information Modeling (BIM)	10/58
• Power-Interest Matrix	5/58
• Dependency Structure Matrix (DSM) and/or Dependency Mapping Matrix (DMM)	4/58
• Integrated Project Delivery (IPD)	2/58
• Various Digital Methods	2/58
• Hierarchical multi-criteria decision models (MCDM)	1/58

(SNA) with 14 examples out of 58. The SNA is a research approach that primarily examines social structures by employing network and graph theory techniques.[11] It has found extensive application in organizational management, construction management, risk management, bibliometrics, and public admin.[11] SNA is a method that can be also used for studying stakeholder relationships. Although many researchers point out the importance of "the network of relationships" very few focus on analyzing the network itself.[5] Social Network Analysis assumes that "all members of the network are connected to each other through relationships although they are all independent" and thus would be a suitable method to analyze and examine stakeholders' needs and responses as well as creating organizational strategies.[12] There are many benefits of using SNA in stakeholder analysis and management. First of all, it allows the project manager to visualize a complex and complicated web of relationships. Secondly, it transforms social relationships into quantitative data that can be evaluated and therefore can be considered a more rigorous analysis of stakeholder impact.

***Various Methods of Stakeholder Mapping*:** There are many ways used to analyze, model, and manage stakeholders. In the literature research, some methods encountered were the use of tree graphs, arrow diagrams, spider web graphs, text mining, comparison graphs, collaboration framework, etc. Sometimes instead of using a formal method, project managers or researchers prefer using simpler methods such as tree graphs, spider web graphs, arrow diagrams, comparison graphs, etc. This allows a quick and simple aid to visualize the stakeholders involved. The Q methodology can be used to manage stakeholder engagement. The research points out that Q methodology is useful for "stakeholder analysis that allows for anticipation of unforeseen stakeholder issues or concerns and to kick-off a participatory procedure with external stakeholders".[4] Using a mapping technique, in general, is beneficial for measuring project success by evaluating stakeholder satisfaction in construction projects.[6]

***Building Information Modeling (BIM)*:** BIM has been defined as a revolutionary technology in the architecture, engineering, and construction industry. One of the most beneficial features of BIM is that it has the potential to improve project practices not just in design but also in procurement, prefabrication, construction, and post-construction.[13] Although at a technical approach, BIM serves as a tool for the parametric modeling of structures based on objects,[14] BIM is also used by a network of participants that are specialists in their own fields for projects which require collaboration. BIM is considered a collaboration tool since it brings together the fragmented nature of the construction industry. BIM also lets all stakeholders of the project collaboratively manage the building design and the construction process. Another benefit is that BIM makes sure the data is understandable to all participants throughout the lifecycle of the project. It defines all roles for actors and makes sure all tasks are completed at the correct time. BIM can also serve as a contractual document management system which constitutes a serious portion of stakeholder management.[15]

***Power-Interest Matrix*:** One of the oldest methods of stakeholder management is the power-interest matrix. The identification and classification of stakeholders is the most important step for successful stakeholder management. In order to classify them the factors that motivate each stakeholder and the demands each stakeholder may have has to be defined.[16] The power interest matrix was created by Johnson and Scholes (1999) where they defined two axes power vs. interest and then tried grouping stakeholders according to their intention and the power to take action. By doing so the project manager can have a better understanding of how he should manage relationships and communication between all stakeholders that are affected by and have an influence on the project.[17] In the power-interest matrix, the stakeholders are divided into 4 groups where actions to be taken by the project manager change according to their location on the matrix.

***Dependency Structure Matrix (DSM) / Dependency Mapping Matrix (DMM)*:** Many stakeholders of construction project management are all integrated and the actions of one surely affect another as well as the whole project. It can be said that there are direct and/or indirect dependencies between all stakeholders. The Dependency Structure Matrix (DSM) (or Design Structure Matrix (DSM) / Dependency Mapping Matrix (DMM) in other sources) is a tool to "model, visualize and analyze the dependencies among system entities".[18] Although not established specifically for construction, the DSM has been widely used to model and manage complex systems with many actors with interdependencies, which makes it extremely suitable for stakeholder management. However, one has to

have extensive knowledge of DSM in order to model it or read it. Therefore it may take longer than other methods create. However, once the DSM model is built it can serve as a platform for all stakeholders that enables organizational learning and process improvement.[19]

Barriers to Successful Stakeholder Management in the Construction Projects

Although different approaches exist to stakeholder management, various barriers are also discussed in the current literature. Although the construction industry has many stakeholders involved systematic stakeholder management is usually neglected. Supporting this idea, there is a lack of successfully structured plans, methods, and strategies that the project managers can apply because of this, it is observed that the project managers usually choose their Stakeholder Management method randomly without any scientific research or previous data in the construction industry. This may unfortunately cause the project to be unsuccessful.[6] Although regarded as less crucial in the construction industry, inadequate management of stakeholder needs and concerns will lead to conflict and controversy in the implementation of the project.[20] As a part of this study, in order to investigate possible failure reasons in stakeholder management in construction, main barriers to stakeholder management that has been found in the systematic literature review have been grouped as below:

***Lack of Research*:** One of the barriers is that there is not enough research in this field. There are no comprehensive key success factors to define if stakeholder management was achieved successfully. There is also no framework defining what type of stakeholder management should be used for which project. There are still many areas of stakeholder management approaches that have not been tested thoroughly on the actual project. Stakeholder Management research currently focuses solely on stakeholder relationships but does not take into consideration the effects of these relationship networks have on the project itself.[5] Also, it was realized through the research for this paper that although there is some research on the topic of Stakeholder Management, it is very fragmented and difficult to relate to one another.

***Problems Related to Collaboration*:** The main factor in successful stakeholder management is good communication and collaboration. Barriers to collaboration affect stakeholder management in a serious manner. Three main barriers to collaboration can be listed as parties' *fragmentation, lack of shared goal*, and *faulty risk allocation method.*[15] Also on bigger scale projects *lack of collaboration between the public and private sectors* and *difficulties coordinating the motivations/goals of the stakeholders* is a common challenge.[21]

Project complexity/ambiguity: Because construction projects are highly complex, uncertain, and ambiguous, it is very hard to attain successful stakeholder management. Although stakeholder involvement has important effects on project outcomes there are still insufficient skills to make the projects available and understandable to all. There are also not many clear sources guiding project managers to prioritize stakeholder involvement.[5,12] Unfortunately, in some cases, stakeholders are consciously not involved in the projects thinking they would make things even more complicated. Most stakeholders are not informed until it is way too late, which ends up in stakeholder dissatisfaction.

***Stakeholders are Multidimensional/Dynamic*:** Unlike solid data from other management areas such as schedule, cost, quality stakeholder involvement, and satisfaction are multi-dimensional. The data collected from stakeholders are usually on a wide range and unexpected/irregular data is common. The stakeholders' information is harder to quantify and turned into objective data.[4] This also makes it harder to have formally structured stakeholder management plans. The stakeholder management strategy has to change all the time during the lifecycle of the project. Supporting all these ideas, the traditional methods are limited in analyzing stakeholders because the "stakeholders are identified, classified and assessed based on their generic roles"[22] ignoring that they can be multidimensional and dynamic. The main two challenges of successful stakeholder management are the continuously changing relationship between various stakeholders and the unpredictability and inadaptability of a complex and dense network.[23]

***Stakeholder Competency / Uneducated Participants*:** It is stated that no matter how good the stakeholder management used in a construction project is, unless the stakeholders are competent to use it properly, it would eventually fail. The group is considered only as competent as the least competent stakeholder. A good example is a study in which the challenges of training stakeholders on new BIM technology are discussed.

The main problems were the unwillingness of stakeholders to learn new things and adapt to digital ways of working.[24] No matter how well the stakeholder management system is used, without actively participating actors successful results won't be achieved. The main problems faced by participants are that they are either unaware of the concept, not sufficiently educated, and/or denied access to detailed information.[25]

***Powerless Stakeholders*:** The end-users or the communities construct a very big portion of the stakeholders however they have almost no power in the development and construction phase of the project unless the project owner/project manager decides to let them have a say. project managers and owners disregard the importance of public and community consultation and there is usually no direct means of communication channel between the project team and the community.[26] Powerless stakeholders are more likely to adopt aggressive ways to make their voices heard. Because of their disadvantage in power their distrust and tension towards the project would be higher.[27]

Future Directions in Stakeholder Management in Construction Projects

As discussed in this study, all stakeholder management models, methods, and tools investigated above try to provide different solutions for different stakeholder-related barriers that are previously mentioned. However, research states that all these models, methods, and tools still have room for improvement.[15,16,28] As the discussion part of this study, future directions of stakeholder management and things that can be done to improve stakeholder management will be discussed.[11,14,23,29] The forthcoming points represent the unique contributions of this study and are intended to guide future researchers. Upon the conclusion of the research presented in this paper, the following are envisioned as potential avenues for advancing this field.

- To advance current models/methodologies
- To go deeper into the complexities of stakeholders
- To include external stakeholders
- To use a facilitator/mediator
- To prioritize decentralized decision-making
- To study disengagement as well as engagement
- To explore opportunities for digitalization

*To **Advance Current Models/Methodologies*:** All current stakeholder management models encountered in the scientific literature review, lack in some way and are open to improvement according to the needs of the industry and the projects themselves. For example, studies show although has been used for many years the power/interest matrix seems to be static for today's construction industry and does not allow the stakeholders to alter their power/interest base.[10] The classification of stakeholders is limited to only certain groups and changes cannot be applied to the model simultaneously. This is why research suggests, the use of network models such as SNA would be a better fit, since they can visualize not just the stakeholders but all their relationships, and it is rather easier to apply changes in the stakeholder structure. However, the network models cannot model feedback and iteration and therefore cannot represent dynamic decision-making in the project. The network models also suffer from their size growing too rapidly which makes it very hard to read the visual information which can be very complex and misleading.[19]

***To Go Deeper into the Complexities of Stakeholders*:** Existing stakeholder management methods have been described as linear and intuitive. The research points out that current methods often "omit the hidden issues" and "overlook stakeholder interrelationships and interdependencies".[30] Therefore although the current methods used provide some amount of guidance for stakeholder management they are insufficient to understand and respond to the complexities of stakeholder management to its full extent.

***To Include External Stakeholders*:** External stakeholders make up a very big portion of the stakeholder community of a certain project. They are the ones that continue to experience the effects of the project years and years after the construction. Although there are various stakeholder management methods for primary stakeholders (owner, suppliers, customers, sponsor, project manager, project team), a tailored approach for secondary/marginal stakeholders (authorities, unions, consumer advocates, competitors, environmentalists, special interest groups, local community, the media) is missing.[22] Additionally, project managers usually have a strong emphasis on internal stakeholder management because it is directly related to procurement but usually ignores external stakeholders. The project managers usually think of external stakeholder management as a task of public officials.[31] This usually causes tension between the project officials and the public. Stakeholder management methods either should include

external/marginal stakeholders, or new models/ methodologies should be created to observe and address their needs.

***To use a Facilitator/Mediator*:** The issues of communication where stakeholders may be aware of their needs but might not be able to express themselves as clearly as they would like. Some clients/users might not be knowledgeable about construction. In those cases, the concept of a facilitator for the group of stakeholders to guide them into decision-making workshops and provide a healthy discussion environment.[32] The use of "collaborative BIM" where participants are offered a common interface to share ideas and/or concerns.[15] The idea of using a facilitator/mediator should not only be thought of as a person but also as facilitating software. This would help all stakeholders to meet on an equal ground although they come from very different backgrounds.

***To Prioritize Decentralized Decision-Making*:** Another challenge of current stakeholder management methods is that one person (usually the project manager) is taken accountable for managing a very large group of stakeholders. Rather than a "single central controller" all stakeholders should have an indispensable and unique say in the governance of the project. This would require new ways of communication, trust between all stakeholders, and a transparent environment to make sure all stakeholders can act on their role.[27] However, trying to involve every single stakeholder would create a complicated web of communication and a big load of data that has to be analyzed. New ways of data and communication management should be created in order to achieve this.

***To Study Disengagement as well as Engagement*:** Most research focuses on the engagement and involvement of stakeholders. However, studying disengagement patterns should also be considered important in future research since it can teach project managers which relationships are riskier for the project.[33] Especially, with large groups of stakeholders such as the public, methods to study engagement and disengagement patterns could provide important information on public influence. Therefore stakeholder management models should also focus on exploring disengagement or disagreement patterns.

***To Explore Opportunities for Digitalization*:** Stakeholder management methods should be turned into digital (computerized) versions to accommodate today's digital world. Future research should analyze and try different technologies to see if they would be beneficial to stakeholders.[28] Most stakeholder management methods suffer from not being able to manage the amount of data that comes from a crowded group of stakeholders. Using digitalization and big data technologies might solve this problem. The digital revolution that the world is currently in would provide more conventional solutions, enhance collaboration and communication, and improve customer relationships.[34] Similarly, many of the Industry 4.0 technologies are suitable for stakeholder management. For example, construction companies can communicate the design of the building with future users by using digital technologies such as augmented / virtual reality and mobile devices[35] and by doing so can strengthen communication and understanding amongst stakeholders. Digital tools offer numerous chances for stakeholder engagement, and each of these tools comes with distinct advantages and trade-offs that contribute to the creation of value.[29] The digital technologies that can be used for stakeholder management are not limited to the examples given above and there are vast technologies that could be used to benefit stakeholder management. However, not many practical examples are encountered in the literature.

Discussion

As construction projects get more complicated, stakeholder management becomes a crucial success factor. Since the satisfaction of stakeholders defines the success of the project, current trends and limitations of stakeholder management methods have been investigated in this research, as well as making suggestions for future improvement. This has been done in 3 sections: defining the current methods being used, defining the barriers encountered, and discussing future directions in stakeholder management. It has been concluded that various ways of analyzing, modeling, and managing stakeholders exist. The use of Network-theory and/or SNA has been the most popular method followed by Building Information Modeling (BIM), Power-Interest Matrix, and Dependency Structure Matrix (DSM).

The main barriers in stakeholder management can be categorized in six main groups. These are lack of research,[5] problems related to collaboration,[15,21] project complexity/ambiguity,[5,12]

stakeholders being multidimensional/dynamic,[4,22,23] stakeholder competency / uneducated participants,[24,25] and powerless stakeholders.[26,27] Most of the barriers encountered in stakeholder management are social barriers rather than technical ones since the matter deals with human beings and their relationships. Stakeholder management should not be seen as just the project manager's job but more collaborative ways of involving all stakeholders should be investigated.

As a result of this research, it was realized that stakeholder management has been done in a rather shallow way and overlooks stakeholder interrelationships and interdependencies. Future research should focus on the deeper complexities of the stakeholders - relationships, dependencies, and conflicts searching for the root issues - since they eventually surface as problems in the projects.[30] The improvements should focus on the inclusion of all stakeholders, including both primary and marginal groups, and not leave any significant groups out.[22,31] The current mapping and modeling techniques aim to visualize the complex net of stakeholders but not many can keep up with the dynamic nature of stakeholder management. Future research should explore designing a dynamic model that can keep up simultaneously, where both the needs of the stakeholder and the position and number of stakeholders can constantly change in a project.[10,19]

All stakeholder management models build on one another in order to improve the gaps left by the previous models. Considering this, current stakeholder models can also be advanced with the changing needs of the construction industry. As the whole world is becoming more digital, the digitalization of the abovementioned methods would solve many issues and also help with the agility problem of the current models.[28,34] The digital age that the world is experiencing suggests we have more inclusive building processes and higher communication with the end-users.[29,35] Although a very crucial part of the project, stakeholder management still has many ways to grow and improve, and the digital age is full of opportunities that can be applied to improve stakeholder management and the construction industry in general.

Conclusions

In conclusion, this research highlights the crucial role of stakeholder management in construction projects, where collaboration is paramount. Existing methods include a variety of analytical tools, from Social Network Analysis to Building Information Modeling. However, the study also exposes several barriers, especially social ones such as emphasizing the importance of addressing human relationships, competencies, and power dynamics. The research suggests a transformation towards more inclusive and collaborative stakeholder management and engagement, with a call for deeper analyses of stakeholder needs and interdependencies. Moreover, the digital age provides promising opportunities to enhance communication and agility in stakeholder management. As the construction industry evolves, so should stakeholder management strategies to ensure project success and satisfaction across all stakeholder groups.

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