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INFLUENCE OF PERCEPTIONS OF TEAM PLAYERS ON INNOVATION IN PROJECTS – A CASE OF LEAN IMPLEMENTATION IN INDIA

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ABSTRACT

In the present study, Lean construction introduction was treated as an innovation in construction. Not much empirical evidence exists to understand the relationship between the Lean tools and the effectiveness of the Lean implementation. The present study aims at filling this gap by understanding the relationship between the team dynamics in big room meetings- a Lean tool- and the effectiveness of the Lean implementation. To this end, social network analysis was used as a research tool to study a case of lean implementation on a large industrial project in India, where the lean construction as innovation process is still at the infancy stage of learning as well as in implementation. The networks created out of project meeting gives insight regarding the team dynamics that played out the big room meetings and how such dynamics impacted the PPC –a measure of the effective implementation of Lean construction on projects. Thus the study contributes to the debate of empirical understanding of effectiveness of innovations and in illustrating the social network analysis as a possible tool to understand the processes of innovation in construction projects.

KEYWORDS

Innovation, Project Team Coordination, Lean Construction, Social Network Analysis

INTRODUCTION

Projects are by their very nature temporary endeavors where the team members work for a fixed time to achieve an objective and move on to other projects. In such a time bounded environment, introducing innovations into such ventures thus becomes a challenge as the team members may not have enough time to realize the benefits and cope up with changes introduced by such innovations. Construction organizations thus face a huge challenge when introducing product or process based innovations in the projects. An important innovation in processes in the recent past is the model of Lean construction. Lean construction aims at introducing efficiency in construction by primarily eliminating waste in various processes involved. Lean practices if implemented effectively, promise to bring improvement in the quality to the project

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and huge savings in material, space, personnel and time. Thereby, Lean promises in improving the overall economics of the project and organization. Implementing Lean construction usually means shifting to new processes and change in the culture at an organizational level. The projects transforming to the Lean culture have to account for the learning curve effects where they allow the team members to adjust to the new paradigm of working and the change in the processes, while taking care to still adhere to the timelines and budget committed. The promise of Lean implementation though may derive benefits to the organization in the long term, for the first few implementations, where the Lean is introduced as a process based innovation there might be some turbulence observed when the expectations from the Lean philosophy are still being discovered. This further gets complicated if the organization itself has not completely brought into the philosophy. In such circumstances, organizations try such innovations on a pilot basis on a few project and evaluate the benefits of shifting to the new philosophy.

As, the mainstreaming of the innovation, in this case the Lean Construction practices, hugely depend on the success of the innovation on these pilot projects, it becomes important to understand how projects and project teams perceive these innovations and subscribe to them when introduced in an organization on a pilot basis. The twin challenge of developing the culture and trust among team members about the innovation and the limited time to achieve this makes innovation management on projects complicated. The management of the innovations introduced in projects thus becomes an important area of study for organizational researchers. This becomes the motivation of the present study where we try to understand how innovations in processes and culture like Lean construction are perceived by team members when introduced in projects. In this article the social network analysis is used a tool to understand the relationship between how actors interact among themselves to how good the innovation gets percolated in the project. We take the case of an industrial construction project in India to illustrate this relationship.

LITERATURE REVIEW

The increasing pace of infrastructure development across the world has put immense pressure on the construction management processes to effectively deliver within time and cost. Such pressures have resulted in the need to have technological innovations in the construction management processes. Traditionally, the construction sector is characterized by significant barriers to innovation. The project structure of construction organizations have proved both a barrier and facilitator for innovation on construction projects (Bygballe and Ingemansson 2014). The highly fragmented nature of supply chain in construction combined with the discontinuity in teams as members move from one project to another are cited in literature as some of the key barriers to innovations in construction sector (e.g. Dubois and Gadde 2000; Winch 2003). However, increasingly it is being observed that such barriers are being overcome by technological innovations both in product as well as processes associated with construction. There are many key drivers to innovation which are identified in the extant literature. The project based factors like project complexity, technical problems in construction, client requirements are often cited as reasons for innovation adoption on projects (Pellicer et al. 2014). On the other hand, the macro factors related to the organization, industry and the country of implementation also play a role (Ozorhon et al. 2007).

On a whole, the construction industry across the world comprises predominantly of project based organizations. Such organizations are characterized by lack of long term relationships among the team members and the need for networks of communication and coordination among various members of the organization (Morris 1982). Thus the process of introducing and mainstreaming innovations become challenging (Jin and Levitt 1996). The importance of the upper management in driving innovation to the various project teams thus become important (Tatum 1987, 1989)

In the past decade, Lean construction had gained wide popularity as a technological innovation in construction processes to eliminate waste make the projects more efficient. With its origins in the manufacturing industry where it was extensively used to streamline the production flows to minimize wastes, Lean has been adopted on a number of construction projects across the world with some success in making the projects efficient. As the Lean principles translate from manufacturing to construction, there is a need to accommodate the distinguishing features of construction as compared to manufacturing. Such features include the predominant on-site implementation, uniqueness in the scope and complexity of the projects and increased uncertainty as a result of highly fragmented supply chain in construction (Salem et al. 2006). Waste identification, reduction and elimination are the primary characteristics of a Lean implementation to improve the overall efficiency in construction. The promise of Lean is to save substantially on time and cost of implementation by streamlining processes, work methods adopted on construction sites, thus achieving greater economies in the project. Usually, the implementation of Lean in construction projects would amount to a change in the existing processes of the project organization in a radical way. This is combined with introduction of a number of Lean tools like Last Planner systems, Big room meetings, PPC charts etc. The shift to Lean goes beyond just these techniques and would often involve a radical shift in the organizational culture at all the levels of hierarchy in an organization (Ballard 2015).

In the seemingly unique projects which are taken up by the project organization, Lean philosophy tries to identify the underlying common processes involved in construction projects. To this end, Lean involves the thinking about the systems and processes which are commonly involved across the projects in a construction organization (Tommelein 2015). Thus, the introduction of Lean in an organization will involve rethinking of various processes of the organization to incorporate the various tools of the Lean construction. The various tools of Lean construction require a greater amount of coordination and collaboration among the team members than required in the traditional project delivery approaches (Forbes and Ahmed 2003). Such coordination is required especially on complex projects where different activities have larger interdependencies on the other activities.

Coordination among the various team members become really crucial in identifying such interdependencies and sorting out the barriers to streamlined implementation (Bertelsen 2004). E.g. There needs to be an interaction between the MEP contractor and the structural contractor to understand some the constraints which may hinder the installation of utility racks when other structural activities are also being implemented simultaneously. The tools like Big Room meetings actually help facilitate such interactions where the team members can highlight the conditions precedent for each of them to perform some particular tasks according to the project schedules. Thus, the Big room meetings aim at increasing the collaboration among the team members which

is crucial in the successful implementation of any innovation like Lean on projects (Pellicer et al. 2014). The success of Big room rests in the fact that all the team members – including the sub-contractors, vendors, material suppliers and clients – are present in these meetings (hence the name “Big”). The constraints are resolved right across the table and promises are made by the team members on how much work can be performed by each of them till the next meeting (usually a meeting). The number of promises kept by the members is usually kept track by a measure called PPC (Percent Plan Complete). The PPC is a measure of how well the team members are keeping the promises made during the last meeting. It is a ratio of number of promises kept in full to the number of promises given the previous meeting. In this sense, the PPC actually measures the reliability and trustworthiness of the team members which is considered a corner stone in Lean implementation (Bossink 2004; Knuf 2000).

The tools like Big room meetings facilitate the means to introduce and sustain Lean implementation and the measures like PPC help in understanding the effectiveness of the Lean implementation by measuring the reliability of the team members involved in the Lean implementation. Thus, the extant literature in Lean construction present the tools like Big room and the measures like PPC to study the effectiveness of the implementation. However, it is often observed that the positive relationship between the tools and measures are taken for granted. The research usually assumes a positive correlation between the big room meetings and the PPC measure. The suggestions in Lean literature are close to normative in these aspects. There exists little empirical evidence to support the effectiveness tools to improve measures. Specifically, for example, there is little empirical evidence that points out that Big room meetings improve the PPC on a Lean construction project. This presents a huge gap in the literature. Understanding this relationship empirically can give intuitions of the structure and organization of tools like Big room meetings for them to be effective. In this study, we aim at understanding this relationship. To this end, we use social network analysis (SNA) as a research tool to empirically understand this relationship.

Social network analysis have been extensively used by researchers to understand coordination in project networks (Chinowsky et al. 2010). Built on graph theory, the most prominent benefit of using SNA to analyse project settings is that it provides an objective and formal means and measures to describe the structural properties rather than subjectively assigning some causations (Scott 1991). SNA provides interesting framework to understand the way the actors on a network interact with each other on the projects or during meetings on a project (Wasserman, Stanley and Faust 1994). These relationships when represented (often as ties between nodes) in a formal way in the social network of the project would provide researchers the means to evaluate different structures and their possible implications to the objectives of the study. Past research has shown the utility of using SNA in project based research due to its ability to represent in an objective manner various relationships and structures like roles, social positions, group, clique, popularity, isolation and prominence etc. Such structures can help understanding the interaction and coordination and knowledge sharing across various actors in a project network (Chinowsky et al. 2008) as against the linear low level of interaction as illustrated by bar charts or any other techniques (Pryke 2004).

The social network analysis as a tool to study the effectiveness of the implementation and mainstreaming of technological innovations like Lean is understudied in the present literature. There are significant gaps in our knowledge in

this area. Studies do not often empirically test the relationship between tools of Lean construction like the big room meetings with their effectiveness in mainstreaming Lean. We address this gap in the present study, where we take the aid of social networks to understand how the interactions and the perceptions of various team members of a construction project influence the effectiveness of the implementation of innovations in the project organizations. Specifically, we take the case of Lean construction philosophy as an innovation on the project organization and study the interactions of team members in a Lean tool like Big room meetings and understand empirically its effect on the effectiveness of the Lean implementation on the project.

RESEARCH METHODOLOGY

To achieve the objective stated earlier, we take the aid of a combination of research methods and tools. A detailed case study on a construction organization in India is conducted to gather data surrounding the Lean implementation. Specifically, detailed observations were taken from one of the flagship projects of the organization where Lean was being implemented on a pilot basis. A combination of qualitative case study based approach aided by social network analysis was used to understand the connectedness of various team players in the Lean meetings and their influence on the effectiveness of the Lean construction on the project under study.

We gathered data related to various aspects of the project to inform our study. The data for analysis included first-person observation by the research team, minutes of meetings, one-on-one interactions with the team members as well as a specific surveys conducted at different points of time the team members to gather relevant data to understand the interactions of the team members with other team members on the project. One on one interviews were also conducted with specific team members to understand the type and level of interactions which happen during the Big room meetings on the project. The combined data was then used to construction project network configurations of the team to depict the interactions of the various team members in each of the Big room meetings.

Such networks were construction over a number of weeks to gain sufficient data to analyze patterns of relationship between the network structure and the measure of implementation efficiency – in this case- the PPC achieved on the project for that week. From the network data, various measures of different members of the team and the crucial team members in disseminating knowledge across the project network were calculated and their correlation with the effectiveness of the Lean implementation as measured by the PPC measures in the construction project was then analyzed. This preliminary analysis threw out some interesting findings with implications to introducing innovations in projects. In the next section we briefly describe the context of research for the present study and present a case study of the project which was studied. This will be followed by the analysis of the data using SNA and the results of the study.

CASE STUDY

For the present study, a huge industrial project by a leading manufacturing company (MC)⁴ in India was selected to do a detailed case study on the Lean implementation on the project. The industry project is a flagship project aimed at expanding the operations

⁴ The actual names in the case study are sanitized for confidentiality reasons.

of MC of the company. The implementation was taken up by the construction division of MC. The top management is fully subscribed to the Lean construction philosophy and the contracts signed with the sub-contractors and vendors all had explicit clauses of use of Lean practices on the project. The project was then selected as the key project to demonstrate that Lean can be used on large construction projects of the organization.

The project involved a number of internal client divisions for whom the expansion was planned. The project team included 11 prominent organizational stakeholders including members from the procurement, construction divisions as well as sub-contractors, vendors, consultants and project management partners. The project employed a number of lean techniques: Big room meetings, Just-in-Time, Last Planner, Planned Percent Complete, 5S (Sort, Set-in-Order, Shine, Standardize, and Sustain), Root Cause Analysis, Work Sampling, and Continuous Improvement. These techniques were exercised by various teams after examining their suitability to the work. The Big room meetings are predominantly taken up by the project to improve the coordination and collaboration among the team members of the project. The project teams used to meet every week to discuss the constraints and interdependencies associated with the planned tasks in the weekly look-ahead plans. The teams would then promise the project the activities and work that each of them would accomplish in the next week. The teams met the next week to look at the percentage of such promises kept (measured by the PPC during that week). The root cause analysis for the promises not kept was done. Then the team continued with the usual constraint identification and the promises for the next week.

The research team was involved in observing the team dynamics from very early into the project implementation. The minutes of meeting, the PPP measures and all data pertaining to the project are shared with the research team. The research team gathered data from various sources on the project. Data pertaining to the case study is collected thorough: Big room meetings, Formal and informal meetings, Telephonic calls, e-mails and Minutes of meetings (MOM) and one on one interactions. All this data was then formalized in the development of social networks depicting interaction among actors in the Big-Room meetings.

DATA ANALYSIS AND DISCUSSION

GENERAL PERCEPTION OF THE TEAM TOWARDS LEAN IMPLEMENTATION

The data collected through interviews revealed the general trends in the team members' perception towards Lean implementation in the project. More than half of the respondents believed that implementing lean construction results in higher profits; decreased construction time; increased quality and safety; and reduction in rework. During the one on one interaction most of respondent said they had a clear vision of what they did and coordinated work better using lean construction techniques compared to the traditional approach. They found themselves to be more involved in the process and using lean techniques they were better able to determine constrains earlier in the process.

Value addition, conflict management, waste reduction, and profit gain were the prominent benefits of lean construction on this project. In spite of push from the top management team on bonding, collaboration, and teamwork, members were reluctant to socialize among the team outside of the project setting. Time was the most critical benchmark for majority of project participants followed by sustainability and

safety at the same level. Most people involved in the project believed that lean practices brought changes in their organization in transparency, profit, and technical aspects. People believed that there is an incremental change in process and trust, on the other hand, a few participants felt that it did not bring much change in the level of trust and the process used on project. Project participants responded stating that they subscribed to lean because they believed: it as a better approach, it would satisfy end-users requirement; and top management push. Everybody felt that lean principles made work more coordinated and improves the level of transparency in the project. Additional buffer time and overall process improvement were the other important result due to implementing lean construction. While two-third of the participants agreed that lean principles help establish trust in the project team while the other one-third were not sure if it actually helped in building more trust.

SNA OF THE BIG ROOM MEETINGS

The data from the minutes of meetings of Big room meetings combined with the observations from the team members and one-on-one meetings with various team members formed the basis for the construction of social networks of the Big room meetings.

A network was constructed for each of the meetings, where the nodes are represented by the members who are part of the project team. Any interaction between the team members which was captured by the observations and the minutes of the meeting were used to form the ties between the nodes. If a team member A raises a constraint for which B is responsible, a link was formed between A and B in the network.. The number of interactions between A and B as indicated by the number interactions raised by A towards B; and B towards A added to the strength of the ties. It should be noted that the team members may raise a constraint addressed to another team member who is not present for that meeting. This data was also captured and the ties were created with such nodes which are designated as absent nodes. The network was constructed in this manner for every Big Room meeting over a span of 3 months. Thus 11 networks were constructed for the period of 4 months when the team studied the behavior the team members.

Figure 1 illustrates a typical network of the meeting after it was constructed using the interaction data. The green nodes are the members present for the meeting. The red nodes are the members not present in the meeting. A quick look at Figure 1 illustrates that some constraints were raised against the team members who are absent in the meeting. Also there were team members who were present in the meeting but did not have any interactions with the proceedings of the meeting. These nodes were represented by green at the left hand top corner of the network as illustrated in the Figure 1. Apart from the usual measures of the network, the total interaction in the network was also measured using equation 1.

$$TI = \sum_{ij} t_{ij} \text{_____ Equation 1}$$

Where t_{ij} = the strength of tie between nodes i and j

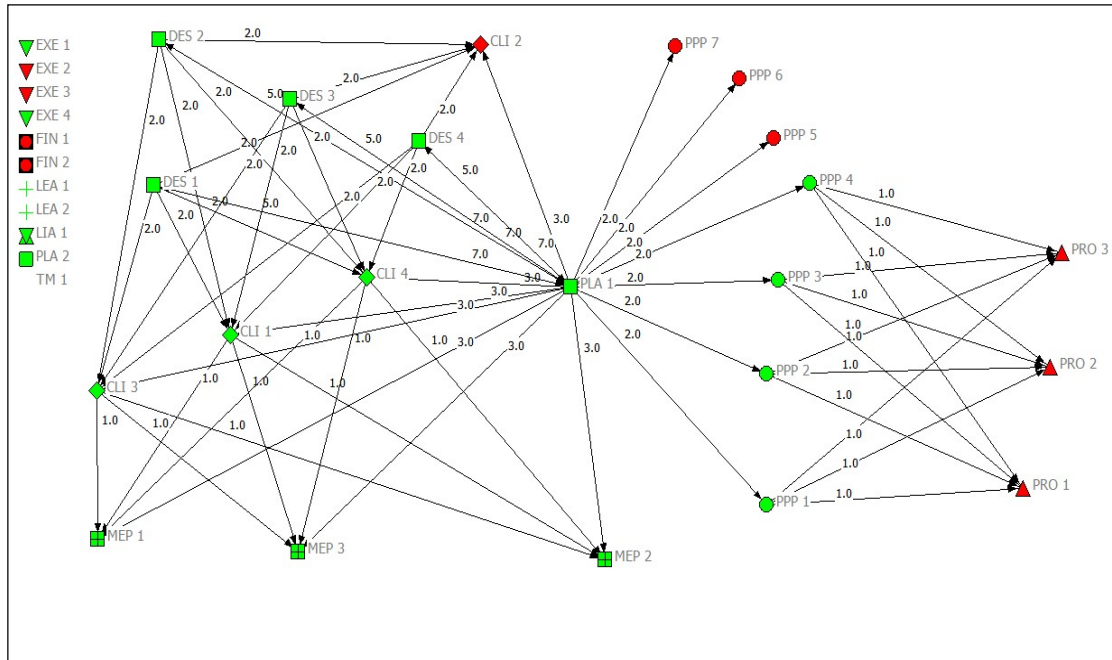


Figure 1: Project networks with greater interaction among the team members

In addition to the total interaction, another measure called the attendees interaction was also calculated as given by the equation 2.

$$AI = \sum_{ij} t'_{ij} \text{-----} \text{Equation 2}$$

Where t'_{ij} = the tie strength between i and j when nodes i and j are present .

The PPC data during this period was also obtained from the project management. Table 1 illustrates the data obtained from the meeting networks constructed over the period of 4 months.

Table 1: Network ties and density from SNA and PPC from Lean

Dates	Network density	Total Interaction (Ties)	Attendees Interaction	PPC
23-Sep-15	0.13	136.00	107	41.67
30-Sep-15	0.07	76.00	48	18.33
7-Oct-15	0.04	37.00	26	2.5
14-Oct-15	0.03	34.00	30	5.24
21-Oct-15	0.03	29.00	19	-17.74
28-Oct-15	0.02	20.00	5	6.25
4-Nov-15	0.01	13.00	13	-3.12
18-Nov-15	0.01	8.00	3	-8.33
25-Nov-15	0.02	24.00	19	-8.34
9-Dec-15	0.08	85.00	57	-1.58
30-Dec-15	0.06	64.00	30	-46.67

Figure 2 illustrates a plot of the PPC over the period along with the TI for the period. As evident from the plot, the PPC curve closely mimicked the interaction curve during this period.

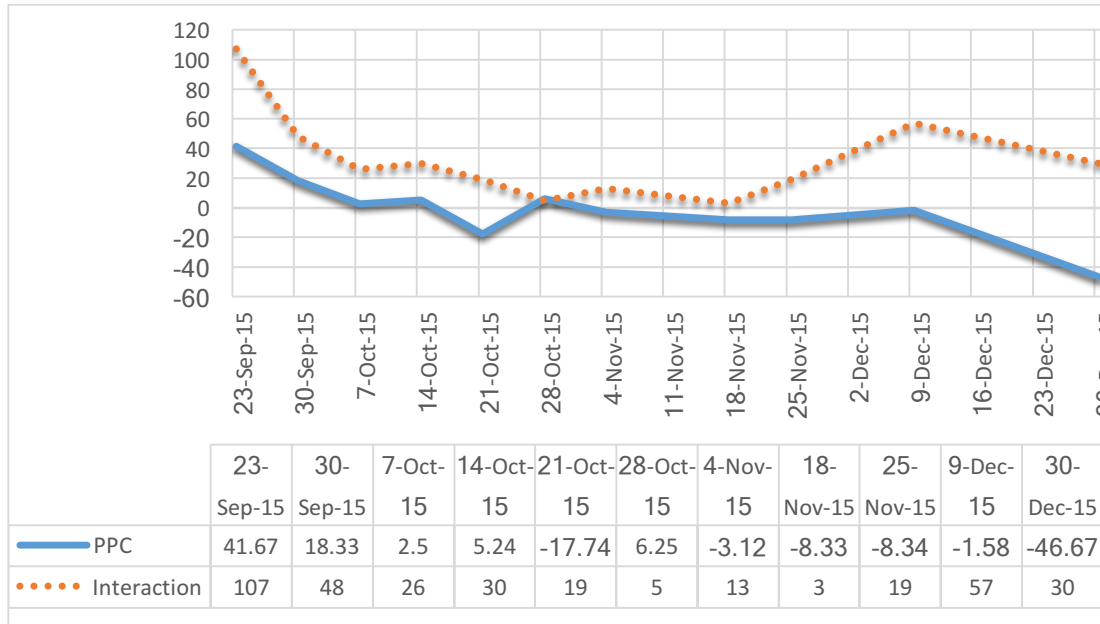


Figure 2: Project network PPC versus Interaction of team players

This is further strengthened by the positive correlation which was exhibited between interaction and PPC. Table 2 illustrates the correlation between the PPC and the interaction as observed in the data.

Table 2: Correlation between Attendees interaction, density and PPC

	Attendees Interaction	Density	PPC
Attendees Interaction	1		
Density	0.97	1	
PPC	0.60	0.48	1

Thus, it can be inferred that a higher degree of interaction in the “Big room meetings” led to a higher PPC measures in general. The pattern was consistent right through the 11 meetings which were observed during this period. Though the number of data points are small, this preliminary analysis clearly indicates the trend where the higher interaction among the team members in a “Big Room” meeting usually results in a higher PPC.

Apart from this general patterns some unique behaviors were observed about the network structure and its relationship with the PPC measure. Figure 1, as illustrated earlier, was from the initial meetings. As evident from the figure, the network was dense with a number ties between various members. Each node interacted with more than one member. Also the issues were raised predominantly to the members who were present in the meeting. Finally, the team members who were present and had no links

to the network was small compared to the number of nodes in the network. However, as the project progressed through time, different network structures were observed. These clearly indicated the team dynamics as the project went through the Lean implementation. Figure 2 illustrates an interesting network pattern for one of the meetings. As observed in this figure, the meeting had a high number of absentees. The interaction among the team members was also minimal and there were cliques which appear in the network. As expected, such network behavior would yield greater realization of constraints which resulted in a sharp fall in PPC the week following this meeting.

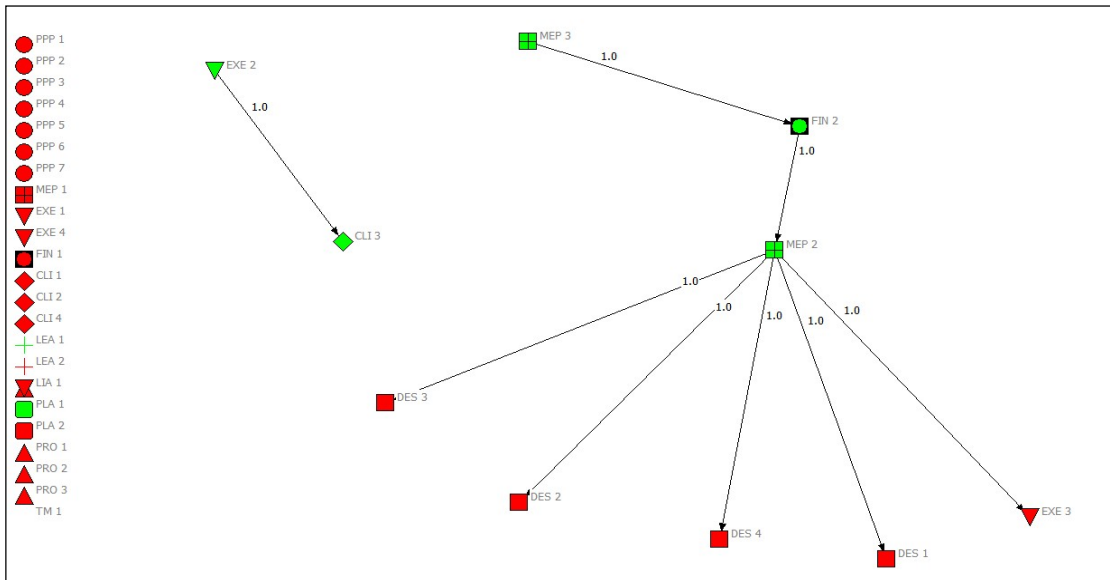


Figure 2: Network structure illustrating cliques in the big room meetings

Further, Figure 3 represents another such meeting interaction network.

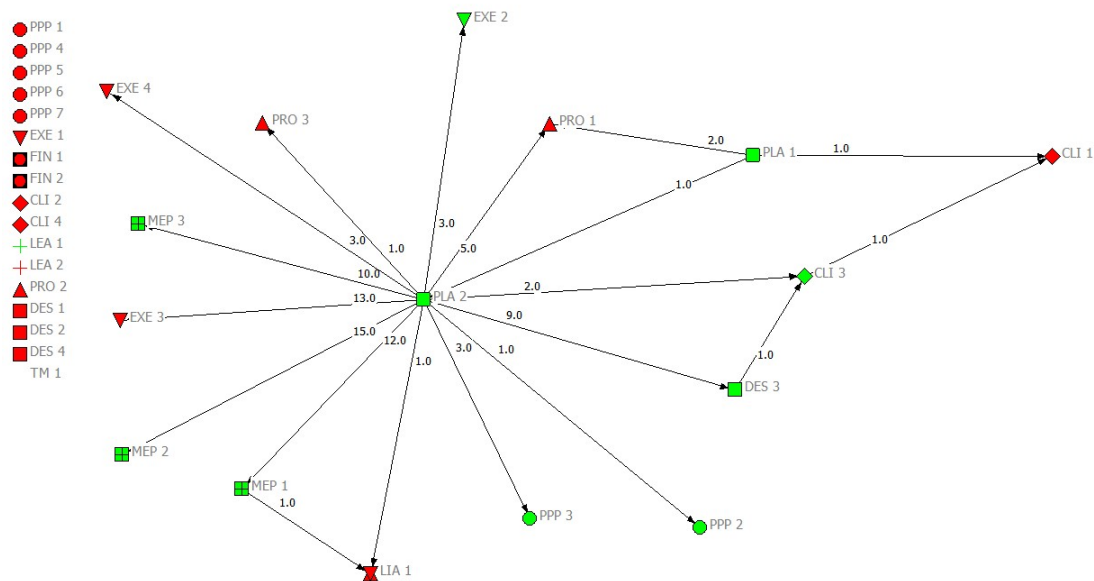


Figure 3: Network structure with high degree of centralization on one node

As illustrated by the figure, the team dynamics during this meeting is quite different from the other two networks. Here, it could be seen that one member of the team was at the center of the meeting where a number of constraint was raised. Though the meeting was attended by higher number of people than that of Figure 2, the interaction is minimal between nodes apart from the central node. Hence, the SNA can highlight the different dynamics as played out in meetings. It should be noted that in this study, a relation between the different structures and its effect on the effectiveness of the implementation as measured by PPC data was not analyzed for the lack of sufficient data. However, the preliminary analysis pointed out at the relationship between the interaction levels in a big room meeting with the PPC data in an empirical manner. It is interesting to note that despite a number of meetings where the top management clearly stated why Lean construction is being introduced on the project, there are significant differences in the meeting dynamics as the project progressed. It is observed that while some members move from periphery to the center of the meeting network, the others migrate from center to more peripheral positions. Again, enough number of observations are not present in the present study to draw some conclusions on this migration and its effect on the innovation percolation in the project. However, from the interaction of the research team with the project team members it is observed that the perception on the effectiveness of the Lean implementation relate to the member's position and connectedness to the project network.

CONCLUSION

The findings from the analysis indicate that there is some level of dependence on the dynamics of the team members in a Big room meeting and the effectiveness of the implementation of an innovation in organization by taking a specific example of Lean construction on a large industrial project in India. This study presents the preliminary findings of the data collected on the introduction of Lean construction in projects. Though we are limited by the amount of data we have and the findings are preliminary in nature, the study indicates the need to understand the dynamics of meetings of team members and usefulness of social networks as a tool to analyze these dynamics and innovation research. Further studies can aim at trying to gather a large number of data points to establish strong empirical relationships between various elements of innovations like Lean construction. The study indicates that there are significant gaps in our understanding these dimensions of innovation management and thus provides an opportunity for project and organization researchers to explore this area further. On the other hand, the findings can help the industry to better manage their project team compositions so that the innovations are successfully percolated and sustained over the project and mainstreamed to the organization.

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