# How are institutional logics guiding BIM adoption pathways?

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## Abstract

Each project is unique, so are the organizations and the way they make decisions. The decision to bring about a change and implement new technology depends on a variety of factors. Our study aims to explore how BIM adoption varies from one firm to another, using an institutional theory perspective. Through in-depth qualitative case studies, we identify the different approaches taken by two construction contracting firms and two engineering works departments of public universities in India in their digital transformation efforts. We then further proceed to analyze how those decisions were made and describe the different institutional logics that guided these firms to adopt BIM. Completion logic, the logic of facilitation, innovation logic, and the logic of legitimacy are the different logics that guide the BIM adoption decisions. Finally, we propose several propositions that can assist strategists at firms and contribute to institutional theory literature.

**Keywords**: BIM adoption, Institutional logic, qualitative case study, innovation, legitimacy

## Introduction and background

Building Information Modeling (BIM) is a collaborative way of working that aids the management system to function effectively by embedding a 3-dimensional computer model with key asset information. This brings about innovation, helps in work allocation, determines interdependence, and focuses on coordination. Research works related to the advancements in the construction industry, such as information management and BIM, are carried out worldwide. Many studies have identified the critical success factors (CSFs) for the successful implementation of BIM in the AEC industry. CSFs in the adoption of BIM can be broadly classified into technological, financial, organizational, legal, psychological, and processual (Barlish and Sullivan 2012; Gardezi et al. 2014; Jadhav 2016; Memon et al. 2014; Yee 2014). While one school of thought on enabling BIM adoption focuses on the identification of critical success factors for adoption, this study adopts a perspective rooted in organizational theory.

Construction firms can follow different pathways for technology adoption. The journey followed and what they intend to achieve are linked. The literature talks about top-down and bottom-up approaches utilized by organizations in decision-making (Brady and Walsh 2007). Most firms take a top-down approach for granted, where the top management makes the decisions and the middle and lower management follow the set strategies. While this approach has worked in some cases, some studies also try to unravel the bottom-up approach. We observe typical top-down and an improvised bottom-up approach in our cases with regards to BIM adoption. However, this study aims to understand the different pathways of BIM adoption by two construction contracting firms and two engineering works units of public universities from an institutional theory perspective.

Institutional theory provides a framework to understand how the rules of the game achieve a taken-for-granted approach. According to Mahoney and Thelen (Mahoney and Thelen 2010), 'changes often take place incrementally and through seemingly small adjustments that can, however, accumulate into significant institutional transformation'. The change, be it rapid or gradual, is underpinned by the persistence of original institutional choices or structured political dynamics. The actors belonging to multiple institutional fields can be instrumental in inducing new practices and ideas. Institutional arrangements evolve within the boundaries of the socio-economic environment and are established as a result of social interactions (Furnari 2016). When these actors try to establish their interests, it results in institutional pluralism (Kraatz and Block 2017, pp. 532–557; Yu, 2013). Institutional pluralism is a source of contradictory logics that eventually brings about an institutional change.

Friedland and Alford (1991) introduced the idea of institutional logic. Institutional logic is defined as 'a socially constructed set of material practices and symbolic constructions (assumptions, values, and beliefs) that constitute its organizing principles and which is available to organizations and individuals to shape cognition and behavior'. In other words, logics are taken-for-granted beliefs and practices that guide the actor's behavior in the fields of activity (Battilana and Lee 2014; Besharov and Smith 2014; Friedland and Alford 1991; Scott 2014). When fields have settled prioritizations of logics and elaborated institutional arrangements, the members in the field have a clear idea of what to expect, and the ideas can drive their behavior (Zietsma et al. 2017). In other words, the behavior is not driven by interests but by preconscious acceptance of institutionalized values or practices. The logics helps the actors to understand how strategic interests and decisions are formulated. There have been studies to understand the influence of conflicting multiple logics in programme management and project organization governance (Frederiksen et al. 2021). However, the construction management literature does not explore an understanding of the socially constructed practices that shape the cognition and behavior of individuals and organizations about BIM adoption in construction firms. Thus, this study intends to answer *What are the different institutional logics* *that guide the construction firms in selecting the BIM adoption pathways? How did these institutional logics guide the construction firms in this study on the pathways to adopt BIM?*

It is important to note that we did not begin our study focusing on the theory of institutional logics. Entities such as innovations and legitimacy emerged as we proceeded with the analyses. Through our study we highlight on the different institutional logics at play to bring about a digital transformation in construction entities.

**Research Methodology and approach**

Yin (2003 p. 9) suggests that when the research questions seek to explain 'how' or 'why' a social phenomenon or a contemporary set of events works, over which the investigator has little or no control, then a case study approach is relevant. Hence, our study is based on an in-depth qualitative case study following a grounded theory approach for data analysis. A qualitative case-study approach allows more detailed, exploratory accounts of experiences of the personnel who has lived through the BIM adoption journey. An inductive longitudinal case study approach was performed on two construction contracting firms and two engineering work units of public universities. The cases will be represented as Construction Contracting Firm A (CCFA), Construction Contracting Firm B (CCFB), Engineering Works A (EWA), and Engineering Works B (EWB).

The study delves into the BIM adoption journey by focusing on the different approaches to institutionalizing BIM usage in firms. The adoption of a case-based approach stems from the necessity for empirical data that may offer a cohesive account of the growth of BIM use and how it has affected organizational transformation. There is always the question of how to study evolution. This is because evolution or change generally happens gradually over a period, and the signs of routinization may not be readily recognizable. Hence, interactions with personnel who have been associated with projects using BIM since 2010 helped to understand the journey. These conversations help to understand changes in work practices and the use of digital technology in the past. This study moves away from the project as a unit of analysis to instead explore the practices and institutionalization surrounding BIM from an organizational perspective.

Data collection is primarily through interviews, and secondary data included documents such as contract clauses, progress review meeting presentations and reports. The interview hours were clocked at 90 hours in total. Most of the interviews, around 60 hours, were from CCFA as they were comparatively quite ahead in BIM implementation. Hence, they had more BIM related experiences to share. While CCFB was very hesitant to disclose more details of the projects and specific experiences. However, with 20 hours of data we could identify some of the key concepts related to BIM adoption. While the interview hours from the engineering works division from the public universities were around 8 and 11 hours. To balance the difference in interview hours, secondary data sources such as contract documents and project progress reports were referred. Some in person observations also provided insights on how the firms were adopting BIM. The findings evolve from the data, and no ex-ante hypothesis is considered. The interviews are transcribed either manually or using transcribing software. The errors in the software-generated transcripts were manually corrected. The analysis was done manually through open and axial coding (Corbin and Strauss 2008). Through open coding, we examined the transcripts to identify broader concepts. These concepts were then linked using axial coding.

From the data, we tried to understand where the idea of BIM stemmed from and how that idea got materialized. The support mechanisms used to monitor the strategy and operations of organizations regarding BIM were considered next. The affinity for innovation and the types were identified that enhance BIM implementation. Legitimacy is fundamental for firms to survive in the business, and we looked at how legitimacy affects the BIM adoption journey. We identified instances supporting each of the factors mentioned above. Through axial coding, we identified the different logics that influenced the BIM adoption pathways.

*Research setting*

The construction contracting firms have been in existence for a long time and were found to be perfect cases to investigate how and what brings about a digital transformation. In the case of the public universities, two premier technology institutes of national importance have been considered. One of the institutes has been in existence for more than six decades, and the other one was established only six years ago. There is autonomy in how each institute is governed and run, but there is also some common ground in functioning. Some of the newly established institutes were under the guidance of mentor institutes, and the new directors were from these well-established institutes. Hence, these cases are also of organizations in existence for a long time and trying to bring about a change in the organization with regards to BIM.

CCFA started its BIM journey in 2009 even though the company has been in existence for a long time. CCFA specializes in almost all domains of the construction sector namely- residential complexes, factory buildings, airports, hospitals, metro rail projects, bridges, roads and nuclear powerplants. This firm has separate sub-divisions to handle each type of projects and have offices in many parts of India to facilitate the construction processes. Initially, various project teams started using BIM for their projects to meet their project requirements. Later, the top management decided to formalize the BIM usage across the company. A central BIM team was established to guide the individual sub-division and the organization with regard to BIM implementation and adoption. Each sub-division was assigned a BIM manager to oversee the BIM utilization. They provide training and guidance to the design teams and project site personnel. Each site also had a BIM coordinator who coordinates the BIM uses at the site and report to the BIM managers. The design team comprises of architects and engineers who work on generating the 3D virtual models and issue it to the project sites. Initially, only design and build projects were modelled virtually. These days most of the projects have a virtual model available unless there are security reasons. There are design heads who take most of the decisions and work in tandem with the BIM strategy head from the central BIM team and BIM managers. A few others who were influential in the BIM journey were the VPs of the sub-divisions and the central team who shared their experiences of inducing BIM and the changes that ensued.

CCFB has a long-standing history of being in the business and primarily focusses on commercial, residential and factory buildings. Their BIM journey started in 2010 when a US returnee, inducted into the company, applied and raised awareness in the firm to embrace BIM. They envisaged BIM plans in the initial stages at the top management level. They used external support in the beginning for they lacked the capability. However, the top management could not see the decision fruitful and decided to decentralize by assigning responsibilities to regional offices. The regional offices did not have any specialized BIM teams and additional responsibilities were given to the personnel. Also, no training was offered to the teams and they had to upskill themselves. This was a slow beginning. The knowledge transfer among the different project teams and regional offices were also not great. Quite later, new team members with BIM expertise such as architects and modelers were hired to offer help to the teams and they formed a VDC team.

EWA is associated with a public university in India that has been in existence for more than 6 decades. This department oversees all the construction and maintenance of various facilities on campus ranging from hostel buildings, residential complexes for faculty, staff and married research scholars, sports complex and other academic and administrative facilities. The main personnel involved in BIM usage are the Chairperson, Co-chairperson, superintending engineer, executive engineer, assistant engineer and the junior engineer. Superintending engineer is the head of the department who reports to the chairperson and co-chairperson. This team is also offered some guidance primarily by the faculty members of the department of civil engineering. The idea of BIM and digital technology was offered by a few faculty members who was aware of the benefits of BIM which they learnt about from their foreign counterparts and overseas construction firms. The Central Public Works Department (CPWD) acts as project management consultants especially in large construction projects. In the projects executed since 2010, the EWA has demanded for BIM to be part of the contract and expected the contractors to offer the BIM deliverables. Some of the projects the contractors submitted the deliverables to settle the bills after the construction, while some of them were unable to keep up with the project BIM requirements. The BIM capability of the EWA team is also far below par.

EWB is the engineering works department of another public university, which started around 2015. Though the department is new, their primary objective is to build and maintain the physical infrastructure of the university. As this university is new, there is a requirement to construct all the facilities like academic buildings, research laboratories, hostel buildings, residences for faculty members and guest houses for visiting faculty and researchers. There was clarity of thought from the director of the university to utilize BIM for constructing their campus to avoid rework and faulty construction. A new faculty who joined the institute had previous experience handling BIM and took over as the co-chairperson and later became the chairperson. This faculty offered some basic training to the executive engineers, assistant engineers and junior engineers especially on document management. This team transferred this knowledge to the contractors, who were initially reluctant to use BIM.

**Findings and implications**

For CCFA the idea to utilize BIM was to meet the stringent deadline of constructing a complex airport project in one of the cities in India. Simultaneously, another airport project in another metropolitan city also considered BIM to rectify clashes in the MEP services. Both projects did not have any mandate from the clients. The two project teams sought help from external consultants and tried to build their BIM capacity by working on small portions. Later, the team executed two projects for international clients around 2011 and 2015, respectively. There was a BIM mandate in these projects, and the clients had more clarity on the requirements from BIM. The experience gained from the previous projects helped the teams gain more confidence in utilizing BIM. Explaining the benefits to the top-level management helped to expand the use of BIM. Around 2017, the top management decided to establish a central BIM team to encourage other project teams of the firm and provide help to the teams to enhance their capability. The Central BIM team set up a BIM academy to train the personnel. They also defined new roles and assigned new responsibilities to focus on the BIM implementation, such as BIM managers at the HQ and the BIM coordinators at the project site level.

In the case of CCFA, BIM implementation started small at the project level. The teams considered the MEP services as the starting point and then slowly ventured into different BIM uses and developed the BIM capability. The experiences and learnings from the projects led other projects of the firm by disseminating the learnings of the previous projects. The best practices and guidelines were offered to other teams at the end of the initial BIM ventures. This endeavor was supported by external consultants who provided resources ranging from the labor force to directions and advice on how to reap the benefits of technology.

As the project teams displayed better performance, the top management realized the importance of BIM adoption. This marks the transition from a project level to an organization level. Company-wide changes were observed to facilitate the use of BIM. As the top management supported the various projects through the subsidiaries, there was a great effort to standardize the best practices at the organization level. This included setting up standardized protocols for modeling and Common Data Environment (CDE). At the same time, various project teams (including middle and lower management) were constantly improving and improvising at the project level, thus creating a feedback loop for the top management to reconsider and refine the bespoke norms set in place. In this case, we can see bottom-up with improvisations approach (as shown in Fig 1) with the constant influence of external stakeholders leading to a stable and sustained BIM implementation.

CCFB started its BIM journey around 2010. The global construction market was moving towards digital technology, and the company was enthusiastic to try it out. One of the personnel with some experience initiated the idea to establish BIM. Initially, some projects were considered pilot projects and were done with the help of external consultants. The organization envisaged some ideas about BIM uses but, did not materialize. That led the firm to decentralize and assign the responsibilities of BIM utilization in the projects at various regional offices responsible for carrying out the projects at these local levels. This decentralization resulted in enhanced responsibility on the regional level to expand the BIM implementation. This resulted

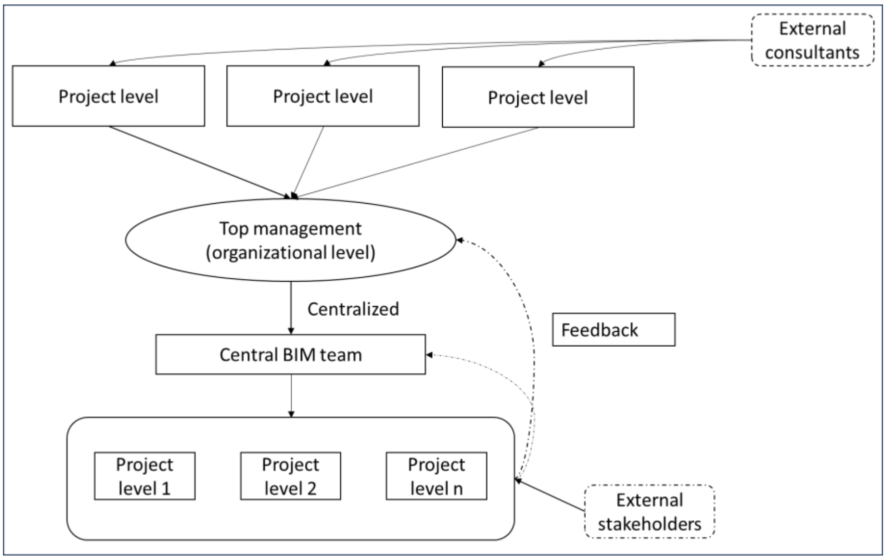


Fig 1. Bottom-up approach with improvisation

in the regional level working on capability building mostly by themselves. Slowly, the project teams got enthusiastic about BIM usage and started exploring the different use cases of BIM.

In this case we observe that there was top management involvement regarding BIM implementation. As the teams did not have the BIM capability, the initial few projects were done by seeking help from external stakeholders. However, BIM usage did not gain traction among the middle and lower management. Hence, they decided to decentralize and make each region to start implementing BIM. Top management made some guidelines and manuals were made available to the teams. Now, the personnel at the regional level and project level had to figure a way out. The teams had to upskill themselves. The top management handled each regional level individually, and cross-learning at the regional level was not occurring. If an improvement was observed in the work practices, then the top management updated the guidelines for all the regional offices. Thus, CCFB has typical top-down approach as shown in Fig 2 with a transient BIM adoption.

EWA decided to try BIM in their projects around 2009 when they were constructing some residential buildings for faculty and married scholars on campus. This decision was influenced by faculty members from the construction management background who had some idea of BIM and explained some of the benefits to the then chairperson of EWA. Since the chairperson was from the department of Civil engineering, he considered this a great opportunity. However, the contractor was not too competent, and the deliverables were submitted for the sake of submissions much after the facility was constructed. Even though there were constant efforts

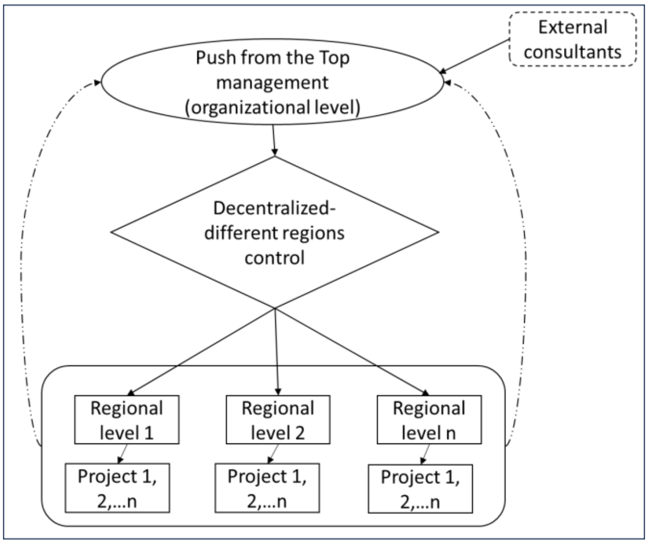


Fig 2. Top-down approach

from the faculty members, the other members of the EW team could not work and support the contractors to meet the requirements suggested by the faculty. The EW team couldn't even cross-check the deliverables in some of the cases. Even during the execution of a project that started in 2020, the contractor failed to submit any deliverables in BIM, and the EW team could only ask for and not take any actions to promote the BIM usage in EWA.

EWA has pressure from external entities such as faculty members, and the top management follows or takes their advice. Because of the involvement of the faculty members, the requirements are part of the contracts; however, finding someone to execute using BIM was a tough task. There wasn't any effort from the top management or the internal team to make themselves aware or enhance the capability of the team. This also led the team to not extend any support to the stakeholders who were part of the projects and expected them to submit the deliverables. Throughout the project, both the internal team and contractors failed to check and submit proper BIM deliverables, and towards completion, some models were submitted 'for the sake' of submission, which the internal team was incapable of verifying. This 'external influence' approach, as shown in Fig 3, led to no BIM implementation.

EWB started its BIM journey around 2016. The director in charge of the institute received help from a faculty member (from another premier institute) on BIM uses and benefits. Since the director realized that some of the issues could be eliminated with the use of BIM, he was interested in taking it forward. That's when a faculty member with quite some knowledge on BIM joined this institute and took over as the vice-chairman and later became the chairman of EW. He gave training to the internal EW team, and later, they helped the contractors with BIM.

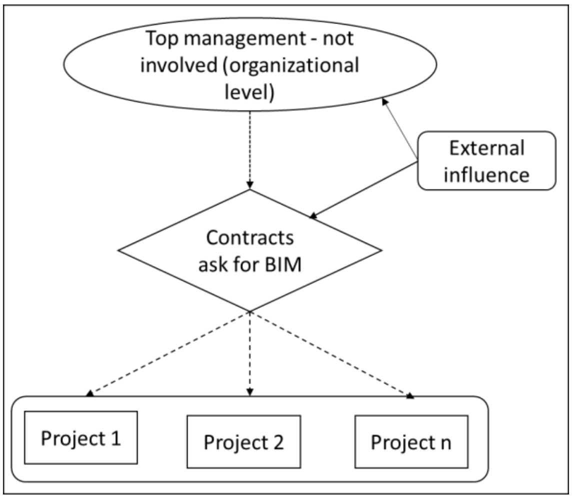


Fig 3. External influence approach

The initial step was to digitalize the document management, where they had a common platform to upload and maintain the drawing following a standard naming convention and document version control. Thus, the EWB has a more robust document management system, while the other BIM uses have not taken off much.

EWB focuses primarily on digitalized document management and has tried to make it robust. The team, led by their chairman, initiated BIM among their internal team. This reinforced the idea and benefits that BIM can offer them. Once the internal team gained some understanding, the other stakeholders who were part of the projects were involved. When they explained their inability, the internal team was able to help them by demonstrating how things can be done. For instance, if they had to upload some of the deliverables, the internal team showed them how that could be achieved. Later, the stakeholders did it themselves under the supervision of the internal team. After a while, the stakeholders could do it themselves. Then, the EWB ventured to demonstrate how 'version control' works. However, the activities surrounding BIM did not take off beyond document management system. So, there's only sparse BIM adoption that can e observed. EWB also demonstrate a top-down approach as shown in Fig 4.

We can observe that these firms follow a different approach in pushing BIM utilization. All approaches have resulted in different levels of BIM implementation and adoption maturity. In the next section we discuss how can we better understand the pathways these firms followed and outcomes that they arrived at.

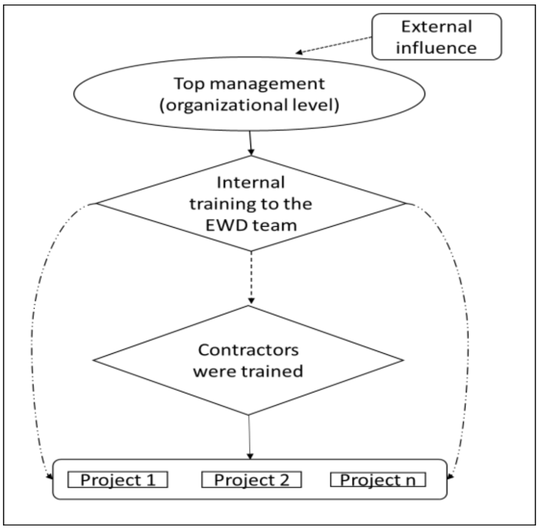


Fig 4 Top-down approach

**Discussions and conclusions**

We set out to identify the pathways of BIM adoption and the strategies guiding these firms to achieve it. It can be seen that the BIM implementation happens differently with each of the cases. These strategies can be explained through institutional logics. Based on the analysis from the observations, we arrived at logics that determined how these firms decided BIM utilization. These logics are completion logic, logic of facilitation, innovation logic and logic of legitimacy.

*Completion logic* can be defined as values, assumptions, and beliefs, materialized in practice and artifacts, that assume completing a project using digital technology such as BIM. This is enabled through the logic of facilitation and innovation logic. This is an overarching logic guiding all the firms. The driving purpose of using BIM is to complete projects on time and within budget, which, in many instances, is too much to expect from the construction industry. When there were stringent deadlines, they had to resort to the use of BIM. According to the design head from CCFA,

> *"It was a huge project, in terms of stringent timelines, to be ready before* [a major sports event]*, multiple stakeholders, etc…Stakeholders involved from govt agencies such as Ministries, customs, immigration to suppliers and vendors. Hence, there was a great need for coordination, and integration of work to meet the challenging timeline. So, there was a need for technology to help us out to deliver the project."*

Then there is *logic of facilitation*. This logic is defined as values, assumptions and beliefs, materialized in practice, that is guided by the support offered to the teams to promote the use of digital technology. The support categories can be identified as follows:

1) Passive support - where the project teams are forced to use BIM and submit the deliverables without much support from the firm or external consultants. This should not be confused with the idea of regulation because there are no standing instructions from the company or the organization, still the top management because of the external influence, pushes the team without providing any support from their end.
2) Partial support- the teams are given some help in terms of training and upskilling but do not provide constant support. The top management wants the teams to realize the benefits and take it forward by themselves rather than being made to implement due to the involvement of the top management.
3) Proactive support- the project teams are self-motivated, and the top management provides support to keep the teams up to date with the improvements in the technology and promotes awareness of the digital technology. They provide training to the personnel. It also offers help to some of the sub-contractors to enable the information sharing and the process of information flow in BIM. As told by a Head- operations,

    > *"Today, yes CCFA has taken the lead and we do in BIM for our own and we carry our vendors also with us… some people* [sub-contractors and vendors] *said they don't have capability. We said, no problem, we have… So, this also helped us to get everybody to start producing in their BIM."*

It should be noted that providing support alone doesn't warrant BIM implementation. This condition is supplemented by the firm's enthusiasm to innovate. Thus, the next logic in play is the Innovation logic.

*Innovation logic* is defined as values, assumptions and beliefs, manifested in practice, that assume innovating and implementing new digital technology as a task among many tasks performed to complete the project. We adapt the framework suggested by Partanen et al. (Partanen et al. 2014), where they combined two dimensions of innovations- the nature of innovation and the revolutionary of innovation. Nature of innovation is of two types- systemic innovations as 'innovations requiring new adaptations or changes in the supportive infrastructure' (ibid pg 6), and adhoc innovation is innovations that are temporary innovations that are compatible with the existing infrastructure. Revolutionary of innovation involves incremental and radical innovation. In incremental innovation, 'refer to the gradual development and value-added improvement of existing products and technologies', while radical innovation involves upgrading by assimilating new technology out there (Ringberg et al. 2019). According to this framework, we arrive at four different types of innovations, which is shown in Fig 5.

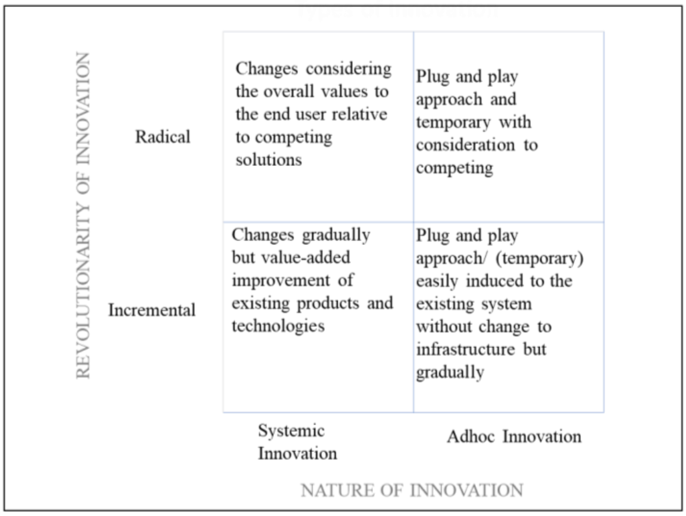


Fig 5. Types of Innovation

Finally, the *logic of legitimacy* determines BIM adoption pathways, which can be defined as Values, assumptions and beliefs, manifested in practices and artifacts with regard to BIM implementation, that assume completing projects maintaining professional legitimacy, within a competing network of actors. We also find that these logics are enabled by 3 kinds of legitimacies (Suddaby, 2017). The effect of three types of legitimacy on these two logics is explained later, which helps to understand how BIM adoption is achieved. Adopting the three types of legitimacy suggested by Suddaby et al. (2017), we consider the following.

1) Legitimacy as property – Here, legitimacy is conceptualized as a capacity or trait possessed by some organization.
2) Legitimacy as process – Here, legitimacy is considered as an emergent or structured set of activities that describe affiliation acquired in a social order.
3) Legitimacy as perception – In this case, legitimacy is a conception of validity as a collective level of judgement that makes them capable of executing certain activities.

Combining these logics, we arrive at a network that would help to identify the pathway that help in BIM adoption which was followed by the firms. The network is shown in Fig 6.

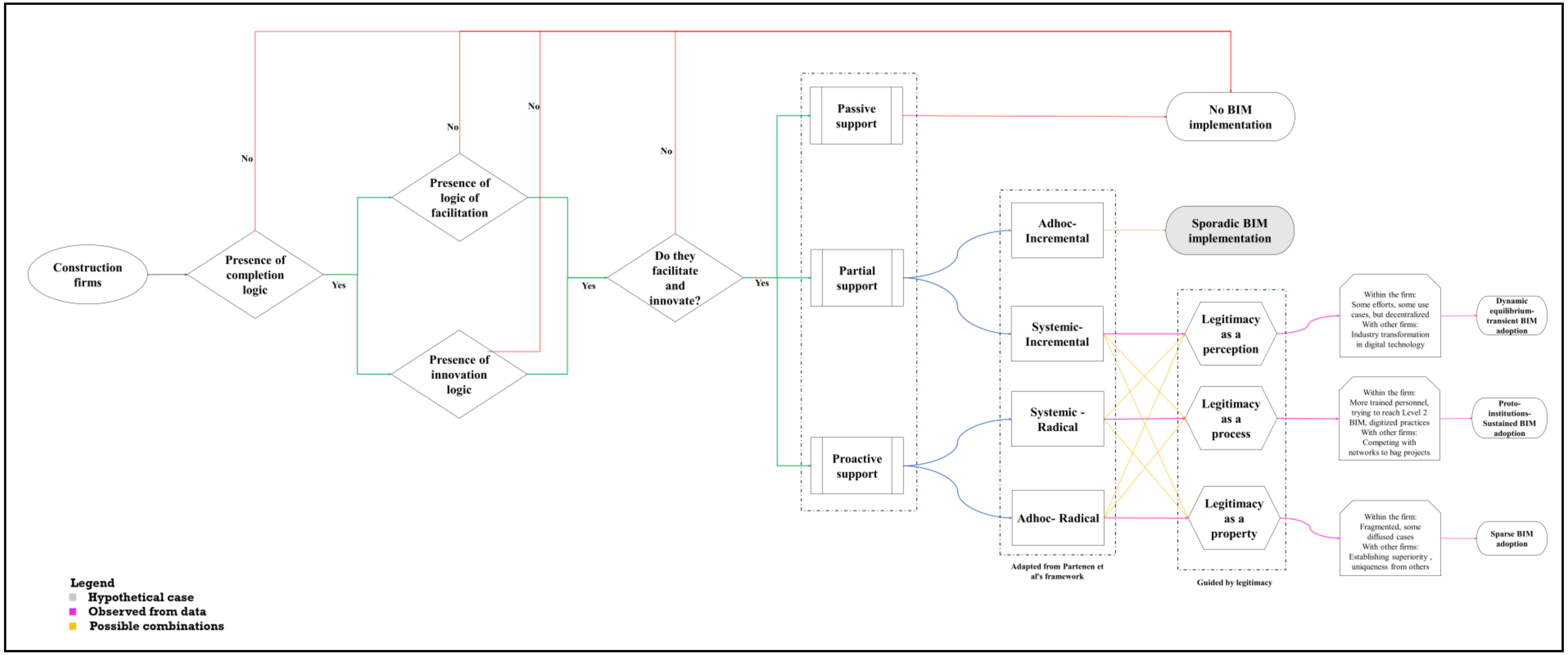


Fig 6. BIM implementation pathways

Some of the pathways suggested are explained as propositions (P). *P1: Radical innovation, along with systemic innovation, when guided by legitimacy as process, has a higher chance of leading to proto-institutionalized BIM adoption.*

In this situation, companies hinge largely on their workforce and leverage cutting-edge technology to drive change. Advanced technology plays a vital role in driving the change considering the values to the users relative to the competing solutions. Additionally, they allocate resources towards recruiting and training professionals to bolster their reputation and credibility throughout the transition. This strategy promotes a smoother and more seamless integration of the changes being enacted through purposive efforts of personnel.

*P2: Radical innovation, along with adhoc innovation, when guided by legitimacy as property has a higher chance of sparse BIM adoption.*

The adoption is sparse because innovation is temporary and not grounded, also it's more about trying out the new technology available in the market. There is not much thought behind the use or need of new technology innovation. Instead, this adoption is carried out eyeing survivability among the contemporaries. Especially when there is chance that the newly established organization need to project their technical superiority of their innovative practice, identified as pragmatic legitimacy by Suddaby et al (2017), among the peers. In such scenarios, the idea of sustained BIM adoption is far from possible.

*P3: Partial support most likely results in incremental innovation that is guided by legitimacy as perception and tends to dynamic equilibrium.*

Due to limited support from top management and a lack of enthusiasm from other personnel, innovation occurs gradually with a focus on improving existing processes and technologies. Although the decision to change is based on societal norms of digitalization in construction and a desire to lead the industry shift towards BIM adoption, individual capabilities are not yet aligned to achieve this goal. As a result, the system remains in a state of dynamic equilibrium with no observable change.

*P4: Proactive support and radical innovation do not guarantee sustained BIM adoption.*

It should be understood that a successful and sustained BIM adoption by the firms is not solely dependent on the availability of new technology in the market. Our research shows, from the pathways, that the nature of innovation and the type of legitimacy plays a crucial role to develop a sustained BIM adoption. Through this proposition we intend to point out that when there is radical innovation carried out by the internal team to advance the utilization of BIM, there is greater consideration of competing solutions and leads to potential instability as teams experiment with new technology before fully understanding why they use what they use. By consistently utilizing and understanding the need for BIM, a more sustained adoption and institutionalization can be achieved.

We set out to identify different institutional logics guiding the firms in adopting BIM and found that completion logic, logic of facilitation, innovation logics and logic of legitimacy are some of the logics influential in deciding BIM adoption. We also identified different pathways followed by the firms under the influence of the logics. The ideas inferred from the pathways offer the industry with options to realize their current pathways and developing more robust pathway to change. The paths can be identified from the propositions. It can be observed that the bottom-up approach with improvisations seemed more successful in BIM implementation as observed in CCFA.

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