# Effects of the exogenous shock of COVID-19 on BIM subsidiaries in India

## 1. **Introduction**

The construction industry involves a web of organizations comprising a diverse range of stakeholders, each of whom contributes a unique set of skills at distinct points in time. The networked nature of construction projects requires collaborative work, on-the-job training, and a consistent and reliable flow of information among stakeholders, sometimes coordinated using global virtual teams (GVTs). Global Virtual Teams are *"teams whose members transcend time, space, and culture"* and interact through computer mediated communications (Jarvenpaa & Leidner, 1998, p. 01). In addition, because the modelling and coordination aspects of construction work is outsourced to South-Asian countries due to the easy availability of technical talent at competitive rates that reduce the overall cost of construction projects (Bresnen et al., 2005; Manning et al., 2008; Nayak et al., 2009; Scott, 2011), organizational learning capacity is an essential quality for BIM organizations to coordinate GVTs efficiently.

The coordination challenges and trust creation in GVTs in the construction and design industry are well documented in Manning et al. (2008), Sattineni (2008), and Ramalingam and Mahalingam (2018) for nominal exogenous shocks. In the past, organizations designed their means to cope with change according to their understanding of how they responded to similar shocks (Styhre et al., 2004). This may have worked well for minor shocks, but major exogenous shocks are novel and their evolution less visible.

In 2020, COVID-19 was an exogenous shock that disrupted the BIM industry network when government responses brought economies to a halt with lockdowns on public movement and physical interaction. The disruption pushed the construction industry to new limits of adaptability to survive, forcing BIM organizations to create new work and communication patterns in the first few weeks and continually improvise because the conditions kept evolving.

The purpose of this research is to compare the inter- and intra-organizational coordination and collaboration patterns pre- and post the COVID-19 disruption to identify work practices that contributed to BIM organizations' resilience (Sutcliffe et al., 2003) against the disruption. Using organizational learning and the lenses of sense-making and event system theory to frame the research, interviews were conducted with 30 employees at eight BIM organizations in India. Texts were subjected to open axial coding and the codes to fuzzy-set qualitative comparative analysis. This extended abstract is concluded with some observations about the implications of the preliminary findings of the research.

### 1.2 Organizational Learning

Organizations adapt to continuous minor external changes by introducing small-scale interventions in daily working processes; these measures help turn threats into opportunities, and the amount of effort involved in the process defines the degree of risk and uncertainty in the situation (Trifu,

2017). The process of adaptation is related to an organization's learning capabilities (Styhre et al., 2004), and "*An organization's fundamental learning capability represents its capacity to generate and generalize ideas with impact (change) across multiple organizational boundaries (learning) through specific management initiatives and practices (capability)*" (Yeung et al., 1999, p. 11).

Organizational learning is characterized as *"centered in the intellectual and emotional capabilities of the individual but is what is taking place within networks of actors and entities"* (Styhre et al., 2004, p. 4) in the construction industry. Since learning is not confined to a single entity or person, organizations devise specific guidelines to control and regulate organizational learning (Sutcliffe et al., 2003).

The factors promoting change and the response of organizations can be studied through two lenses. The first is a *sense-making process* (Weick et al., 2005) that helps decode the sequence of responses by focusing on multiple aspects of organizations, for example, "the structure of a small outfit" when businesses meet sudden dangers and "the sources of resilience" that prevent disaster (Sutcliffe et al., 2003). The second lens is *event system theory* (EST; Morgeson et al., 2015), where the scale of *disrupting events* is discontinuous (Hoffman et al., n.d.) and external activities are the focus (Dohrenwend et al., 1993; Perkins, 1982). EST highlights the risks encountered with a disruption (Morgeson & DeRue, 2006) and can help identify particular events that accelerate disruption, trigger organizational responses, and create opportunities. *Event criticality* defines the "degree to which an event is significant, vital or essential" to an entity (Morgeson & DeRue, 2006), and the higher the event criticality, the larger the number of resources required to deal with it.

This research is focused on the collaboration and coordination of digital project management and delivery in BIM service providers. The aim is to develop a framework for understanding the organizational learning that resulted from the COVID-19 disruption. The objective is to identify how virtually connected BIM organizations coped with the sudden change in work conditions and highlights how trust formation was a new exercise between people who previously worked together under normal office conditions with physical interaction and daily communication. The research attempts to decode organizational adaptation and behavioral changes in BIM subsidiaries and their parent companies or clients in response to the COVID-19-induced exogenous shock and thereby contribute to knowledge about both digital transformation construction management and resilience in BIM organizations. The resilience of each case studied will be compared by performing a cross-case analysis of the factors affecting the responses of each organization using an augmented technique called qualitative comparative analysis (QCA).

## 2. **Research design and methodology**

The study is specific to GVTs in the architecture, engineering and construction (AEC) industry that were subjected to COVID-19 lockdowns. Research exploring the adaptive capacity of family firms in Germany during the COVID-19 pandemic about behavioral changes and digital technologies (Soluk et al., 2021) provide insight into how organizations develop adaptive capacity and help create a framework for data collection. Although the research methodology and analysis are different Soluk et al.'s (2021) research is helpful because it explored various events that triggered behavioral changes. Research on resilience (Naderpajouh et al., 2020) provides

understanding of how project and resilience research amalgamate in work environments and emphasizes that decoding the formation of temporary teams and leaders (Grabher, 2004) must be studied at the individual team/group, project, organizational, industry, and societal levels of an organization to understand variations in the project environment that trigger overall behavioral change. These studies assisted with identifying the underlying parameters that affect organizational learning and adaptation in BIM organizations in response to exogenous shocks.

## 2.1 Data Collection

To ensure a diverse dataset and help broaden the perspective of the problem, the research included eight BIM organizations (labelled S1 to S8) of various sizes and with different characteristics located in India (see Table 1). Organizations from India were selected to maintain sufficient similarity in their exposure exogenous shock.

Because the research is based on comparing variations between previous and current practices in response to changes in the work environment due to the COVID-19 disruption, data was collected using ethnographic interviews with employees in the eight selected organizations so that the layers of shock responses and interactions amongst various levels in these organizations could be systematically examined. A total of 30 interviews took place telephonically and 14 hours of audio recorded. The data was collected over nine months, between May 2021 and March 2022.

Interviews were focused on identifying what behavioral patterns helped with organizational resilience to the shock. Data were collected in two sets. The first set of interviews were open-ended interviews designed to collect rich data on the effects of shock on the organizations. A total of six people participated in the first round, four from S1 and two from S6. Interviews were transcribed verbatim. NVivo coding was used to preserve as much data as possible. After better comprehending the situation, a semi-structured interview protocol was designed and conducted with the remaining 24 participants.

The semi-structured interview covered themes like the time taken in transition, new tools introduced to work from home (WFH), intra-team and inter-organization communication patterns, new quality check processes, knowledge and data transfer, change in organizational structure, trust amongst actors, and temporary team formation. These themes allude to factors that affect decision-making processes in organizations.

## 2.2 Data Analysis

For better understanding, the organizations were grouped according to their selection of knowledge and data transfer methods after the shock because this decision affected their inter-team communications and became a significant factor in trust building (Jarvenpaa & Leidner, 1998) within the LVTs (see Table 1).

**Table 1: Organization demography and cluster**

| | VPN Based Data access | | | Cloud based data access | | | Office Based working only | |
|---|---|---|---|---|---|---|---|---|
| | S1 | S2 | S3 | S4 | S5 | S6 | S7 | S8 |
| No. of employees | 1000-1200 | 300 | 2800-3000 | 1000 | 300+ | 400 | 200 | 40 |
| Clients | Mostly global | UK based parent company | Both Indian & global | Global | US based parent company | Both Indian & global | Both Indian & global | Only indian |
| Top management | Family owned business | Corporate organization | Public sector company (govt. based) | Corporate organization | Corporate organization | Small size corporate organization | Family owned business | Individual owned business |
| Time in transition | 1 week | 3 weeks | 2 weeks | 3 weeks | 0 days | 6 weeks | 4 weeks | 8 weeks |
| Trust in employees | Low | Low | Low | Low | High | High | Low | High |
| Data security | High | High | High | High | Low | Low | High | High |

Only three organizations (S2, S3 & S5) predicted the upcoming shock; the rest were taken by surprise. The cross-case observation revealed two patterns related to emerging threats: first was the rapid switch to virtual private network (VPN) based systems that allowed employees to resume working as soon as possible. This strategy kept data storage, communications, and other work practices the same and allowed employees to access the office setup by mirroring the screen on their home setup. Subsidiaries that chose VPN-based working moved back to the office setup as soon as the restrictions were relaxed. The second set of subsidiaries moved to a common data environment (CDE) where the entire project was operated on a cloud-based system; this strategy gave rise to a major learning curve as compared to the VPN-based system and required clients to transfer their projects to a new platform; however, it ensured communication and collaboration as more transparent and focused.

*2.2.1 Data Coding*

The transcribed data were coded using open and axial coding to understand the connections between the effects of the shock and responses by the organizations. Table 2 shows the open codes generated from the raw data according to the events identified during the disruption.

**Table 2: Open codes from transcribed data**

| Themes | Preliminary codes | Final codes | Repetition |
|---|---|---|---|
| **Occurrence of shock (event)** | Sudden switchover<br>Lack of infrastructure limited the scope of work<br>New platforms discovered<br>Exploration of tools<br>QC was difficult without proper tools | Cloud based data storage<br>VPN-based server access<br>Lack of infrastructure<br>New tools used | 05<br>05<br>06<br>20 |
| **Exogenous shock-led disruption (loss of sense-making)** | Increased follow ups<br>Lack of trust<br>Inexperienced with such major shocks<br>Confusion | Frequent follow-ups<br>Lack of trust | 13<br>09 |
| **Communication** | Iterative inter-organization communication such as constant follow up<br>Unsurety about flow of work<br>Exploration of tools<br>Lack of knowledge and structure led to more discussion amongst groups | Iterative QC process.<br>Frequent communication | 11<br>04 |
| **Teething problems** | Coordination was difficult in large-scale projects<br>New process was less transparent<br>Lack of trust led to difficulties in coordination | Multiple communication points<br>Steep learning curve | 09<br>04 |
| **Organizational learning/ enhancement of adaptive capacity** | Once the structure is built and tested, going back and forth is easy<br>No new element was introduced<br>Acclimatization to the work culture made the transition smooth<br>New layers of trust amongst employees were built<br>New queries received from previously unexplored countries | Pre-pandemic proactivity helped work ecology<br>New market opened<br>Patterns appeared in new work culture | 03<br>04<br>04<br>03 |

Post coding, the data was analyzed using QCA techniques to identify pathways for causality between codes and the identified responses.

### 2.3 Data analysis

*2.3.1 Qualitative Comparative Analysis (QCA)*

With more cases, it is exceptionally difficult to identify common and consistent patterns while giving proper weight to the intricacies of the context involved in each instance. As Ragin (1989) states, comparative studies sometimes involve complicated combinatorial explanations that are difficult to verify with standard quantitative analysis. This concern is applicable to this research. Because multiple factors affected the organizational transition for the duration of the shocks, QCA provided a middle path.

*2.3.2 Fuzzy Set QCA*

Various phenomena can be studied at different levels (Ragin, 1989). Thus, it may be difficult to determine if a case is fully present or absent in a causal condition. In addition, real-world situations often exhibit some but not all the input conditions' properties, making it challenging to identify inputs. Fuzzy sets allow partial membership in input conditions, which helped overcome this challenge. Fuzzy Set QCA was therefore chosen as an analytical method in this case.

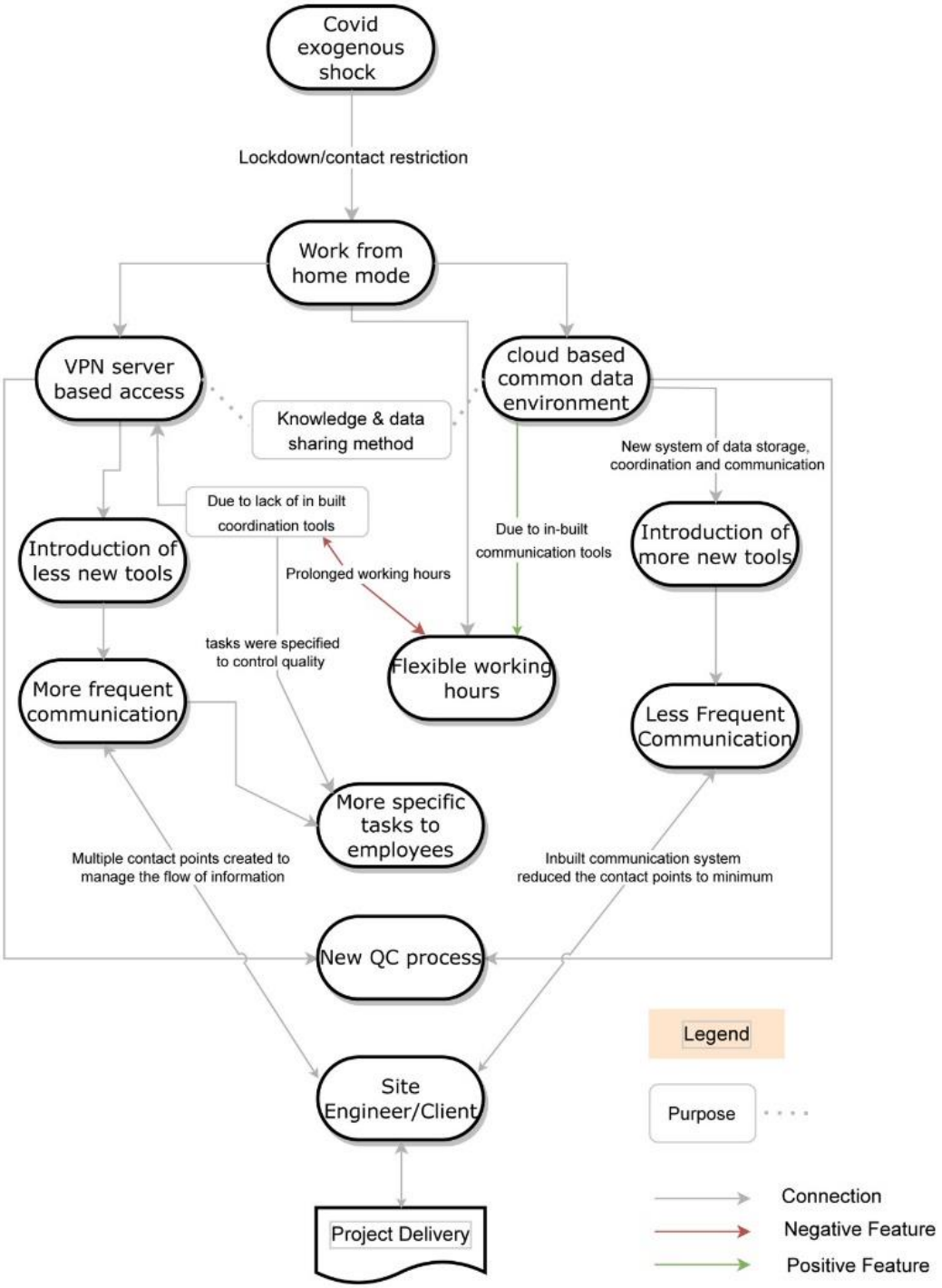
## 3. **Preliminary Findings**

The strong relationship between the processes of organizing and the practices of sense-making highlights the recurring argument (for example, Weick, 1969, pp. 40–42) that individuals organize to make sense of ambiguous inputs and then implement that meaning back into their surroundings to ensure their surroundings and experiences are more coherent. As explained by Weick et al. (2005), depending on a person's perspective, a variation in the environment might be seen as a discrepancy (Orlikowski & Gash, n.d.), breakdown (Patriotta, 2003), surprise (Louis, 1980), disconfirmation (Weick & Sutcliffe, 2001), opportunity (Dutton & Ashford, 1993), or interruption (Mandler, 1984, pp. 180–189). These variations all have the characteristics of disruption, leading to disorganized actions by individuals and organizations. Subsequent attempts to make sense of the event are made to resume a state of normalcy and continue previous courses of action with minimum variations compared to the originally planned efforts.

To create this understanding of events we identified connections between the final codes to understand post-COVID practices (refer Figure 1). Key responses were identified and compared for all the organizations by different methods of data storage. The links show the effects of the events and how their responses led to the formation of new events (modes of knowledge transfer, quality control, formation of temporary structures and leaders in the organization) and these were cross compared with the organizational parameters (such as the number of employees, type of

management, type of clients, and trust amongst actors) through Fuzzy-Set Qualitative Comparative Analysis (FsQCA).

**Figure 1: Post shock practices**



By linking the coded data to various parameters of the organizations, it was found that selection of new knowledge and data transfer systems was dependent on managements' trust of employees; organizations with more experienced formal employees trusted employees with data security and hence opted for CDE for easier workflow. Organizations whose workforce was young or quick-moving (frequent job-changers) opted for VPN-based systems to maintain data security; this played a key role in their resilience during the shock: CDE-based organizations gained employees and clients' trust because the CDE environment gives live access to all participants, thus ensuring the work being executed as transparent.

Along with data storage, multiple new communication tools were introduced to cope up with inter-team communication and data sharing due to extensive and iterative communication between team members working from home, adherence to schedules improved drastically, multiple points of communication from sites were created to manage the magnitude of knowledge transfer, and information was communicated directly to the people in charge of the job; prior to the shock, this used to happen in team meetings between subsidiary and site/client.

Quality control was difficult during this period because access to printing inventory was not available, so tools such BIM 360 and Revu Bluebeam provided features to compare versions of drawings and models with markups.

## 4. **Implications**

By analyzing the findings from organizations against their respective parameters, the weightage of parameters in organizations' behavioral learning processes could be identified. Cross-case comparison using QCA provided insight into common strategies that promoted the success or failure of the organizations studied during the COVID-19 disruption. Findings from the research may help BIM and similar organizations become more resilient to exogenous shocks.

**Keywords:** Building information modeling, exogenous shock, COVID-19, A.E.C. industry, organizational learning.

## 5. References


Arthur K. Yeung, David O. Ulrich, Stephen W. Nason, & Mary Ann Von Glinow. (1999). *Organizational Learning Capability*. Oxford University Press.

Bresnen, Mike, Goussevskaia, Anna, & Swan, Jacky. (2005). *Organizational Routines, Situated Learning and Processes of Change in Project-Based Organizations*.

Dohrenwend, B. P., Raphael, K. G., Schwartz, S., Stueve, A., & Skodol, A. (1993). The Structured Event Probe and Narrative Rating method for measuring stressful life events. In *Handbook of stress: Theoretical and clinical aspects, 2nd ed.* (pp. 174–199). Free Press.

Dutton, J. E., & Ashford, S. J. (1993). Selling issues to top management. *The Academy of Management Review*, *18*, 397–428. https://doi.org/10.2307/258903

Grabher, G. (2004). Temporary architectures of learning: Knowledge governance in project ecologies. *Organization Studies*, *25*(9), 1491–1514. https://doi.org/10.1177/0170840604047996

Hoffman, A. J., Ross, S. M., & Ocasio, W. (n.d.). *Not All Events Are Attended Equally: Toward a Middle-range Theory of Industry Attention to External Events*. http://ssrn.com/abstract=2944055

Jarvenpaa, S. L., & Leidner, D. E. (1998). Communication and trust in global virtual teams. In *Journal of Computer-Mediated Communication* (Vol. 3, Issue 4). Wiley Blackwell. https://doi.org/10.1111/j.1083-6101.1998.tb00080.x

Louis, M. R. (1980). Surprise and Sense Making: What Newcomers Experience in Entering Unfamiliar Organizational Settings. In *Quarterly* (Vol. 25, Issue 2).

Mandler G. (1984). *Mind and Body: Psychology of Emotion and Stress*.

Manning, R., Student, G., & Messner, J. I. (2008). *Case Studies in BIM Implementation for Programming of Healthcare Facilities*.

Morgeson, F. P., & DeRue, D. S. (2006). Event criticality, urgency, and duration: Understanding how events disrupt teams and influence team leader intervention. *Leadership Quarterly*, *17*(3), 271–287. https://doi.org/10.1016/j.leaqua.2006.02.006

Morgeson, F. P., Mitchell, T. R., & Liu, D. (2015). Event system theory: An event-oriented approach to the organizational sciences. *Academy of Management Review*, *40*(4), 515–537. https://doi.org/10.5465/amr.2012.0099

Naderpajouh, N., Matinheikki, J., Keeys, L. A., Aldrich, D. P., & Linkov, I. (2020). Resilience and projects: An interdisciplinary crossroad. *Project Leadership and Society*, *1*. https://doi.org/10.1016/j.plas.2020.100001

Nayak, N. v, Taylor, J. E., & Asce, A. M. (2009). *Offshore Outsourcing in Global Design Networks*. https://doi.org/10.1061/ASCE0742-597X200925:4177

Orlikowski, W. J., & Gash, D. C. (n.d.). *Technological Frames: Making Sense of Information Technology in Organizations*.

Patriotta, G. (2003). Sense-making on the shop floor: Narratives of knowledge in organizations. *Journal of Management Studies*, *40*(2), 349–375. https://doi.org/10.1111/1467-6486.00343

Perkins, M. R. (1982). Minimum Competency Testing: What? Why? Why Not? *Educational Measurement: Issues and Practice*, *1*(4), 5–9. https://doi.org/https://doi.org/10.1111/j.1745-3992.1982.tb00669.x

Ramalingam, S., & Mahalingam, A. (2018). Knowledge coordination in transnational engineering projects:a practice-based study. *Construction Management and Economics*, *36*(12), 700–715. https://doi.org/10.1080/01446193.2018.1498591

Ragin C. Charles. (2008). *redesigning social inquiry*.

Sattineni, A. (2008). Outsourcing And Off-Shoring: Options For The U.S. Construction Industry. In *International Business & Economics Research Journal-May* (Vol. 7).

Scott, J. (2011). Social network analysis: developments, advances, and prospects. *Social Network Analysis and Mining*, *1*(1), 21–26. https://doi.org/10.1007/s13278-010-0012-6

Soluk, J., Kammerlander, N., & de Massis, A. (2021). *Exogenous shocks and the adaptive capacity of family firms: exploring behavioral changes and digital technologies in the COVID-19 pandemic*.

Styhre, A., Josephson, P. E., & Knauseder, I. (2004). Learning capabilities in organizational networks: Case studies of six construction projects. *Construction Management and Economics*, *22*(9), 957–966. https://doi.org/10.1080/0144619042000241417

Sutcliffe, K. M., Vogus, T. J., Cameron, J. K. S. E., Dutton, R. E., Sutcliffe, K. M., & Vogus, T. J. (2003). *Organizing for Resilience. Positive Organizational Scholarship: Foundations of a New Discipline Sweating the Small Stuff: The Foundations of High Performance View project*. https://www.researchgate.net/publication/235792901

Trifu, A. E. (2017). *November2 nd-4 th*.

Weick, K. E. (1969). Social psychology in an era of social change. *American Psychologist*, *24*, 990–998. https://doi.org/10.1037/h0028881

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the unexpected: Assuring high performance in an age of complexity.*

Weick, K. E., Sutcliffe, K. M., & Obstfeld, D. (2005). Organizing and the process of sense-making. In *Organization Science* (Vol. 16, Issue 4, pp. 409–421). https://doi.org/10.1287/orsc.1050.0133