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K. Chandrashekhar Iyer* and Partha S. Banerjee

Project ambidexterity: case of recovering schedule delay in a brownfield airport project in India

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Abstract: Planning deficiencies and consequent execution delays are likely to persist in infrastructure development projects. However, recovery of schedule delay is a less researched area. This case research, using a two-stage inquiry modeled on the grounded theory, studied the schedule delay recovery during the execution phase of a brownfield airport construction project. The analyses generated contextual evidence and ambidexterity was found to be the key underlying phenomenon for successful recovery measures. The empirical learning was validated with literature and can be used by practitioners looking to institute schedule recovery measures.

Keywords: grounded theory, project ambidexterity, brownfield project, schedule delay recovery, airport construction project

1 Introduction

Delays in airport construction projects appear to be a common phenomenon globally (Table 1). Time overruns adversely affect the economic interests of all parties involved in airport development, creates congestion for airlines and hardship to passengers, and hinders streamlining of trade logistics and business. At the same time, there are examples of airport construction performance successes such as on-time reopening of Rome's Fiumicino Runway 2 (Airport Council International 2013).

The Indian civil aviation sector has witnessed growth in passenger traffic over the last two decades and is expected to continue growing for at least another decade. According to the existing investment plans of airport operators, the passenger terminal capacity of all Indian airports put together will increase from 230 million passengers per annum in 2012 to 370 million passengers per annum in 2017 (Planning Commission, Government of India, 2012). The five private airports at Delhi, Mumbai, Hyderabad, Bangalore, and Cochin are expected to handle 60% of this passenger traffic, with state-owned enterprise Airports Authority of India (AAI) handling the remainder.

To handle the growth in passenger and cargo traffic, the country needs simultaneous investments in (a) development of new airports (greenfield projects) in smaller towns and remote areas and (b) expansion and modernization of existing airports (brownfield projects). India has 456 airports and airstrips, of which about 180, need to be functional over the decade. While attractive private finance and increased allocation of public funds are important enabling factors for this large, countrywide program to take off, its ultimate success would depend on minimizing execution delays and cost overruns of sanctioned projects. Hence, the airport construction sector becomes an area of interest for this study.

2 Literature survey

Project performance evaluation and identification of success factors have been well researched (Pinto and Slevin 1987; Garvin 2007; Luu et al. 2008; Cooke-Davies 2002; Dvir et al. 1998; Shenhar et al. 2002; Iyer and Jha 2006). Specifically for construction projects, performance measurement has been dominated by the conventional measures of time, cost, and quality, together termed as the "iron triangle" (Atkinson 1999), and this includes a rapidly growing body of knowledge (Bassioni et al. 2004; Yin and Du 2008; Chan and Chan 2004;

***Corresponding author: K. Chandrashekhar Iyer,** Department of Civil Engineering, Indian Institute of Technology–Delhi 110016, India, Email: kciyer@civil.iitd.ac.in
Partha S. Banerjee, Deft Advisory and Research Pvt. Ltd., New Delhi 110019, India

Tab. 1: Examples of recent airport construction delays across the world*.

Serial No.	City	Country	Description
1	Dhaka	Bangladesh	New greenfield airport land acquisition issues resulting in non-commencement of project
2	Muscat	Oman	Delays due to design modifications
3	Brandenburg	Germany	6-year delay (original opening plan 2010, expected 2016); cost overrun of €1.2 billion; €80 million litigation for poor planning
4	Quito	Ecuador	18-month delay; renegotiation, dispute resolution
5	Santiago	Chile	Re-tendering, quantum of delay to be ascertained
6	Malaga	Spain	Environment clearance delays; change in plans
7	Durban	South Africa	Renovation required within 2 years due to poor design and restricted access
8	Zagreb	Croatia	10-year planning; year-long tendering in 2011; construction started May 2014; expected completion December 2016; optimistic schedule
9	Doha	Qatar	6-month delay in opening to decide the main contractor becoming the airport operator
10	Islamabad	Pakistan	70% behind schedule, audit detected irregularity
11	New Khartoum	Sudan	Multiyear delay to finalize finances (Sudan suffered loss in State revenues due to partition)
12	Campinas City	Brazil	Unsafe working conditions; construction delay

*Note: Data source: Airport Council International.

Flyvbjerg et al. 2003; Cao and Hoffman 2011; Hwang et al. 2010; Toor and Ogunlana 2010; Walker and Shen 2002; Jha and Iyer 2007).

Studies have shown that effective project planning is linked to achievement of project success (Yin and Du 2008; Zwikael and Globerson 2006). The relationship between project planning and project success was empirically analyzed using data from more than a hundred defense research-and-development projects in Israel (Dvir et al. 2003). The findings suggested that project success is positively correlated with the investment in requirement definition and development of technical specifications but insensitive to the level of implementation of management processes and procedures. Infrastructure projects in developing countries are generally performed under higher levels of uncertainty. The lack of both owner's institutional experience and historical data on multiple similar projects leads to initial planning being based on expert opinion and rough estimates. Factors such as resource constraints, unpredictability of regulatory regimes, technology adoption challenges (if applicable), and capacity limitations of teams add to the uncertainties while preparing long-gestation projects.

In practice, planning deficiencies are widely prevalent when infrastructure projects in developing countries are conceptualized and sanctioned. As construction of these projects begins, the deviations between initial plans and actual progress become noticeable, leading to schedule delays and disruptions, cost overruns, and sometimes disputes. Studies from developing countries show that construction projects can benefit from effective project planning, controlling, and monitoring (Frimpong et al. 2003).

The complex dynamics of projects requires consideration of the impact of a portfolio of many (disparate) disruptions, which could be greater than the sum of the impacts from each disruption taken singly (Eden et al. 2000). The portfolio of disruption impacts result in effects that would probably not even occur if only one or two impacts had occurred. Moreover, such combinatorial effects may not be realized immediately and makes it considerably more difficult for project managers to recover from schedule delays as they realize that no matter what they do, the costs keep spiraling and delays get worse (Eden et al. 2000). This sets up a far greater challenging environment for project managers to recover the schedule delays during execution.

2.1 Schedule recovery during execution

The world-renowned Hibernia gravity base structure (GBS) project experienced initial delays. No previous offshore concrete structure has had such complex geometry, in combination with very high rebar densities and strict tolerance requirements. By appropriate construction methods, constructability reviews, putting together a new effective international construction team, and application of total quality management, the GBS project was turned around, and the concrete works were completed on schedule and within budget (Nyborg and Bjorlo 1997). Another study, taking the example of a university building construction project, has proposed a systems dynamics model for schedule recovery from design errors (Han et al. 2013). While concluding that their model helped project managers better understand the dynamics of design errors and effectively recover delayed schedule, the researchers suggested further verification for generalization.

In another work, a team of operations researchers classified uncertainties in project management into two: one that is stochastic in nature and another that is unique, entailing hard-to-predict events of large consequence and which cause disruptions (Zhu et al. 2005). The latter uncertainties, difficult to deal with, are traditionally resolved by the experience and skill of the project manager, often resulting in suboptimal decisions. The researchers attempted to model the "recovery problem" arising out of the second type of uncertainty by focusing on the resource-constrained project scheduling problem. Though the work provided a new way of viewing and resolving disruptions as a project unfolds, their procedures were not tested on real instances.

Besides these, we could not find other studies of how schedule delay recovery has been attempted during execution of large infrastructure projects. It may be that many cases of recovery might not have been systematically analyzed and published. As a result, this largely remains an unexplored domain.

3 Study objectives

Although there could be apparent similarities in managing scheduling problems between projects with small delays and the ones that must be handled after a disruption, the project management approaches would be different. A new paradigm of project management needs to emerge for recovering delayed and disrupted projects, with the simultaneous objectives of minimizing the cost of handling the disruptions and instituting new measures to get back the project on track as soon as possible. At times, disruptions shift priorities, requiring new options to be considered in the recovery process. All these need project managers to take decisions in a far more expeditious manner than they would otherwise do and to continually trade off good, well-thought decisions with those that need to be taken at that hour to speed up the recovery process to avoid further difficulties.

Project managers could benefit if a wider body of research knowledge and harvested learning existed, drawn from cases that were recovered from delays and disruptions. The overarching goal of this article is to study schedule recovery measures instituted in delayed infrastructure development projects and to understand whether any learning or practice can be generalized for adoption by practitioners. Emanating from this goal are the following research objectives:

(a) Develop a structured model of managerial inquiry into projects that face significant schedule delays and disruptions; and
(b) Study schedule delay recovery during execution to understand any underlying phenomenon that could be adopted as a model of practice.

The above objectives prompted us to understand the concept of ambidexterity and its relevance to this study. Though Robert Duncan first coined the term organizational ambidexterity in 1976, the seminal work of James March (1991) is credited to have generated interest in organizational ambidexterity research. His work concluded that an organization needs to exploit its existing competencies to ensure proficiency while also exploring new solutions and adapting to the novelty of the situation.

Research to understand project ambidexterity is at a nascent stage. Moving beyond the current dominant focus of conventional time management practices in projects, this study is structured to understand the underlying phenomenon of schedule delay recovery in significantly delayed and disrupted projects. Such underlying phenomena, if they exist, can intuitively be expected to simultaneously exploit past learning and explore new frontiers of achievement possibilities to recover schedule delays and, hence, are likely to be in line with ambidexterity thinking.

The following sections set out the research methodology: two-stage project management inquiry models to analyze the case of an Indian airport brownfield construction project, for which schedule recovery measures were successfully instituted. The findings from the inquiry are subsequently validated with literature and conclusions are drawn.

4 Research methodology

4.1 Adoption of case study as the research method

The case research methodology is a powerful technique to study systems in their natural settings. This methodology provides unique advantages, whereby the phenomenon does not get isolated from its context, thus allowing the researchers to understand how organizational behavior and processes are influenced by the organizational and environmental contexts (Yin 2003). Other eminent researchers have also found it to be powerful in allowing both researchers and practitioners to study systems in their natural settings, learn about the state of the art, and generate theories from practice (Benbasat et al. 1987). The case study approach has thus emerged as a widely accepted research technique.

Major projects of Indian state-owned enterprises with outlays of more than INR 1,500 million (approximately USD 25 million) suffer significant overruns and disruptions (Ministry of Statistics and Programme Implementation, Government of India, 2014). Land acquisition issues and delays in environment clearances affect greenfield development projects. In comparison, brownfield redevelopment and/or expansion projects have fewer such issues. Furthermore, in a land-scarce country such as India, where significant infrastructure still needs to be built up, brownfield redevelopment projects can provide a range of economic, social, and environmental benefits (Zhu et al. 2009).

While there are a large number of delayed projects in India, very few such projects institute systematic measures for schedule recovery. In another study (Iyer and Banerjee 2016), the researchers had conducted a preliminary survey of state-owned delayed infrastructure projects, each having an outlay of more than USD 200 million. Though each one was a prestigious project, none of these projects had instituted systematic schedule recovery measures. Hence, it was understood that the number of delayed projects that would have instituted such schedule recovery measures would be limited and would need the research team to develop a specific inquiry model for studying the identified project.

At this stage, the research team deliberated on the option of adopting either a conventional structured questionnaire survey that could capture the opinion of the associated actors or a detailed case research approach that flexibly builds up an inquiry model using the grounded theory (GT). While the opinion survey-based approach would be amenable to analysis using statistical tools, thereby easing generalization, it stood the risk of not capturing critical issues and nuances that could be embedded in the natural settings of this case. The researchers chose the case study approach as (a) they themselves were not aware of all facets of the research problem to enable them to prepare structured survey instruments that could comprehensively capture all necessary dimensions, and (b) the respondents were likely to respond only to the questions asked and might not proactively elaborate any missing areas, which the authors thought could require further research. Hence, a case research approach that would enable systematic analysis of how the systems interacted and worked in their natural context was considered appropriate. This was also expected to bring forward new managerial insights, which could form the basis for generation of theories from practice and get adopted in future.

4.2 Choice of GT to generate case data

Glaser and Strauss (1967) were the original proponents of the GT as a qualitative social research technique. Thereafter, in a seminal work, Eisenhardt (1989) synthesized GT with other contemporary works to propose a methodology of within-case and cross-case analyses to build theory from case studies. A subsequent version of the GT was proposed by Strauss and Corbin (1998), who used both inductive and deductive thinking on open-coded granular textual data for systematized generation of theory. Since then, researchers have used GT for descriptive and exploratory case studies, though it is still not widely prevalent as a combined research method (Lehmann 2010; Barrett and Sutrisna 2009; Krueger et al. 2014; Coakes and Elliman 2011). Although the original GT approach prescribed a strict inductive way of generating theory from empirical data, subsequent researchers have criticized it for this pure emergent procedure and advocated combining empirically driven inductive analysis of case studies with preexisting theory-driven deductive analysis to effectively integrate knowledge and develop synthesized theory (Goldkuhl and Cronholm 2003).

Taking cue from this philosophy, the researchers adopted the approach of the original GT in this study to collect empirical project case data through open coding and then inductively grouping them through selective coding. This was then combined with the established the Project Management Institute (PMI) framework (Project Management Institute 2013) knowledge areas, along with its construction extension (Project Management Institute 2007) to develop the anchors. The GT approach followed in this work (Table 2) has been adopted in other recent studies (Iyer and Banerjee 2015; 2016).

4.3 Overall research approach

The study begins by a holistic assessment of the entire case. It then proceeds to develop a two-stage project management inquiry. The first stage of inquiry makes use of the PMI framework and shortlists knowledge areas for further study. The second stage of inquiry, modeled on the GT approach, is then constructed to analyze constraints

Tab. 2: Stages of the GT* study adopted for this research.

Stage	Purpose of the stage
Open coding	Collection of granular text data, such as those from stakeholder interviews, project records. Identified data are tagged and sorted by key points, which have been termed “open codes”.
Selective coding	Collection of open codes similar in concept, which allowed the data to be grouped into “anchors”
Categories	Broad groups of similar concepts that are used to generate theory
Theory	A collection of similar explanations that explain the subject of the research

*GT = grounded theory.

and causality, with variants for brownfield (redevelopment and/or extension) projects. The overall research approach is depicted in Figure 1.

5 Case summary

The status of nine construction projects that were in progress as on March 31, 2011, at different Indian airports is presented in Table 3.

As seen from Table 3, the construction of the Integrated Passenger Terminal Building at the Netaji Subhas Chandra Bose International (NSCBI) Airport, Kolkata, was the single largest airport construction project of the AAI, which was then under progress and had reported a delay of 3 months. At project conception, it was also thought that by managing such a complex brownfield extension project, the AAI would improve its project execution capability.

Prior to commissioning of the Integrated Passenger Terminal Building in 2013, the NSCBI Airport, Kolkata, had separate domestic and international passenger terminal buildings. Around 2005, the international passenger terminal building was beginning to become overcrowded, requiring expansion and provision of more passenger amenities. The expansion and modernization plan for the international passenger terminal building was drawn up. Around the same time, permitting low-cost airlines’ operations in the Indian aviation sector saw a dramatic rise of domestic fliers. This accelerated the pace of overcrowding at the domestic terminal building at NSCBI Airport, Kolkata. While the combined terminals’ capacity was only 5 million passengers annually, during April 2011 to March 2012 alone, NSCBI Airport, Kolkata, served 10.3 million passengers. About 85% of these passengers were domestic fliers.

Anticipating exponential growth in domestic fliers, the AAI had conceptualized an expansion plan for the domestic terminal in 2006 as a separate, but concurrent, exercise along with the expansion of the international passenger terminal building. Subsequently, in 2007, the

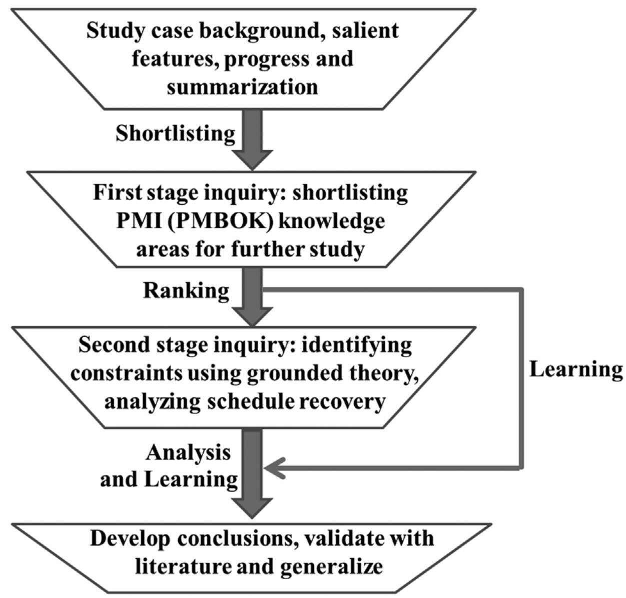

Fig. 1: Overall research approach. PMBOK = Project Management Body of Knowledge; PMI = Project Management Institute.

AAI saw the logic of resource optimization benefits by amalgamating these exercises and constructing a new Integrated Passenger Terminal Building by redevelopment of available land within the airport premises (about 25% of this land was marshy, with a storm water pond of maximum depth of 3 m) to serve both international and domestic destinations. This led to the conceptualization of an Integrated Passenger Terminal Building at NSCBI, Kolkata, designed to handle 20 million passengers annually. It was expected that the current capacity would be sufficient to cater to passenger traffic at least until 2020.

5.1 Salient features of the project

The airport’s new integrated passenger terminal is a wide, V-shaped structure spread over 233,000 sq.m. (2,510,000 sq.ft.) It has two-tier operations for arrivals

Tab. 3: Status of construction projects in airports operated by the AAI* (as on March 31, 2011).

No.	Location	Project name	Project value (INR§, millions)	Physical work completion	Time overrun (as on March 31, 2011)
1	Ahmedabad	Construction of new International Terminal Building	2,909	100% (just commissioned)	1 month
2	Chennai	Development of Terminal Building and pavement works	5,350	27%	No delay reported
3	Chennai	Development of Kamaraj Domestic Terminal Phase-2, and expansion of Anna International Terminal Building	12,730	64%	Delay reported, but not quantified
4	Chennai	Extension of secondary runway, construction of taxi tracks	2,328	99.5%	No delay reported
5	Chennai	Construction of RCC†/prestressed concrete bridge across the River Adyar	2,280	99%	No delay reported
6	Kolkata	Construction of Integrated Passenger Terminal Building at Netaji Subhas Chandra Bose International (NSCBI) Airport	23,250	63%	3 months' delay
7	Gangtok	New airport at Pakyong near Gangtok	2,643	38%	17 months' delay
8	Goa	Construction of new International Terminal Building	3,300	16%	Delay reported, but not quantified
9	Multiple locations	GAGAN‡ Project (the AAI in collaboration with the Indian Space Research Organization, for satellite-based navigation)	3,936	62.15%	No delay reported

*AAI = the Airports Authority of India; §INR = Indian rupee; †RCC = reinforced cement concrete; ‡GAGAN = GPS Aided GEO Augmented Navigation.

and departures, facilitating easy flow of passengers from entrance to boarding (Figure 2).

The new five-level terminal is served by an elevated 890 m roadway leading to the departure facilities, with two lanes to five lanes in front of the new integrated passenger terminal. It contains 128 check-in counters that utilize the common user terminal equipment (CUTE) technology and has 78 immigration counters and 12 customs counters. Passenger lounges are provided by the airlines, and the terminal is equipped with 18 aerobridges and a further 57 remote parking bays. The state-of-the-art, in-line baggage handling system is capable of providing Level-5 security screening. The interior concept is inspired from the works of Nobel laureate Rabindranath Tagore (national poet of India).

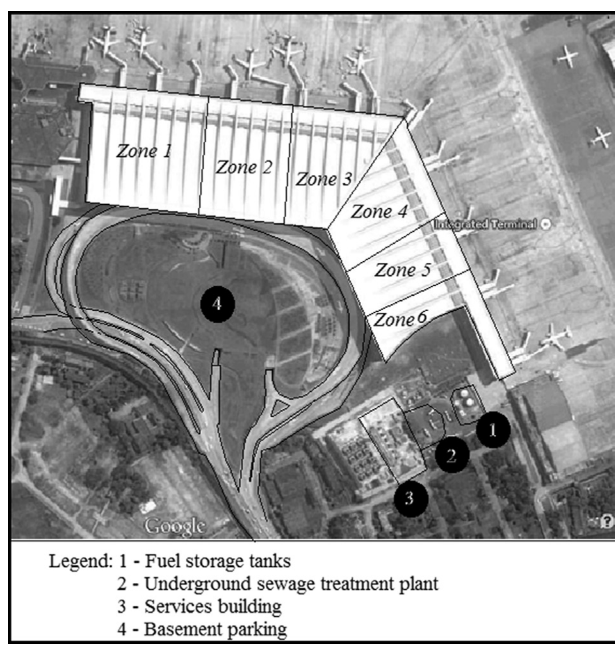

Fig. 2: Overview of the main terminal of the Netaji Subhas Chandra Bose International Airport at Kolkata, India.

5.2 Project approval

The project for construction of a new Integrated Passenger Terminal Building was sanctioned by the Government of India on August 5, 2008, with an outlay of INR 19,425 million (USD 320 million). The estimated cost was revised to INR 23,250 million (USD 385 million) to include multiple site preparation activities, such as relocation and diversion works in the brownfield redevelopment area. An international architect, who had worked earlier with national design firms and was earlier engaged for the domestic and international passenger terminal building expansion works for other AAI projects, was chosen for this project.

The consortium of Thailand-based Italian-Thai Development Public Company Limited and ITD Cementation India Limited was awarded the work in October 2008, with a completion period of 30 months and additional 3 months for the first monsoon, totaling 33 months. The construction supervision consultant was appointed later, 5 months after commencement of construction.

5.3 Construction progress and commissioning

As observed by Shami and Kanafani (1997), renovation projects in airports are complex because operations need to be minimally disturbed. This constrains the performance of construction in terms of scheduling, cost management, safety, security, quality, and regulations.

Though construction at the NSCBI Airport commenced on November 5, 2008, the project progress was delayed primarily due to AAI's inability to clear multiple land encumbrances of the operational facilities within the project area and hand it over for construction. While some of these facilities were relocated and encumbrances were cleared as the work progressed, one of the facilities that were falling in Zone 1 of the new terminal was cleared almost 2.5 years after the start of construction works. In the meantime, as a fallback option, the project management team contemplated bifurcation of the major portion of the terminal work into (a) Phase 1, comprising Zones 2–6, which was nearly 80% of the covered area, along with the approach and exit roads, and car parking facilities, targeted for completion by July 2012; and, (b) Phase 2, the balance portion comprising Zone 1, which was significantly delayed, targeted for completion by March 2013. This would ensure commissioning the major part of the new terminal, thereby easing massive overcrowding at the existing terminal buildings.

However, schedule recovery measures were put in place for the entire work, i.e., from Zone 1 to Zone 6 as if they were part of a single phase. The integrated terminal building was inaugurated on January 20, 2013, by the Honorable President of India. The new terminal was opened to passengers from March 10, 2013, and the project was declared commissioned on March 25, 2013, after about 53 months from the date of commencement of construction.

NSCBI Airport, Kolkata, has bagged the "Second Best Engineering Marvel for the year 2013", conferred by the magazine *Engineering Watch*; "Excellence in Built Environment 2013" award from the Indian Building Congress; "Best Improvement Award, First Place – Asia Pacific" for the year 2013–14 conferred by Airports Council International; and the "Vishwakarma Award 2014" under category of Best Construction Projects, conferred by Construction Industry Development Council under Planning Commission, Government of India.

6 First-stage inquiry

The first-stage inquiry was intended to shortlist applicable knowledge areas of project management for the next stage of inquiry, as suggested in the GT approach. The logic for dropping or short-listing a knowledge area is discussed in the following sections.

6.1 Findings

- **Scope management:** Being a brownfield project with multiple site constraints, as well as planning and design delays, managing the scope within the budget was a challenge. At one point, due to delayed handover of a portion of the site, it was contemplated by the AAI that Zone 1 of the Terminal would be built later and the airport would be commissioned by completing the works for Zones 2–6. This interim contemplation was driven by considerations to operationalize about 80% of the passenger terminal building. Subsequently, as the entire work was taken up for execution as single phase, with no change in the scope, this was not taken forward to the second-stage inquiry.
- **Time management:** The AAI had proposed a longer schedule of 42 months during project conception, but the proposed schedule got curtailed in stages as the proposed project moved through multiple layers of approval. Finally, the original schedule estimate was recorded as 33 months, though this was inadequate for the construction of a facility of this size and complexity. This was a typical example of optimism bias (Flyvbjerg 2008; Siemiatycki 2008) during planning. After commencement of construction works, a committee was formed, which assessed the reasonableness of the schedule. The committee concluded that the completion period of 33 months was unrealistic and 45 months was a more realistic completion time period. With the project being commissioned in 53 months, this meant an overall delay of 8 months. A detailed study revealed that the project could have been delayed even more, but some schedule delay was recovered during execution. Hence, this was taken forward to the second-stage inquiry.

- **Cost management:** The project was delivered within the stipulated budget, and hence this factor was not taken forward to the second-stage inquiry. However, a learning point emerged on budget items that need to be included for site preparation while preparing estimates of future brownfield projects.
- **Quality management:** This study considered conformance to specification as a measure of quality and found examples of rework that was carried out by the contactors at their risk and cost. The impact of rework components got absorbed within the adverse schedule variance, if any, and was not separately tracked during execution. Thus, it was concluded that the rework components did not cause any separate delay or extra cost to the owner. This was a learning point. However, as time management was already selected for further study, this area was not taken forward to the second-stage inquiry.
- **Human resource management:** While PMI recognizes human resources management as a knowledge area, a large engineering construction project such as this deploys multiple resources of labour, equipment, tools, and tackles. Adequate availability, appropriate utilization, and the knowledge to effectively manage all these resources collectively contribute to project success. This corroborates with the resource-based view (Barney and Arikan 2001; Killen et al. 2012; Tarafdar and Gordon 2007), and hence the ambit of study for this area was extended to cover all project resources. It was termed as *resource management* and selected for the second-stage inquiry.
- **Communications management:** Initial study revealed that communications within internal actors and with external stakeholders were managed reasonably well. Periodic reporting by project consultants strengthened this process. Hence, this was not taken forward to the second-stage inquiry.
- **Risk management:** Most risks were identified during planning and hence can be classified as “known” risks. An example is the provision of an additional 3 months of time for the first monsoon within the project schedule. Monsoons are especially heavy in Eastern India and affect excavation work, which gets scheduled at the beginning of construction works. However, some of these “known” risks turned into “unknown” risks with unpredictable schedule consequences as the project entered the execution stage. An example is the schedule impact of AAI’s inability to make available the whole parcel of encumbrance-free land for construction. This delay introduced risks and uncertainties even within the defined scope and soon resulted in schedule delays, which became hard to recover. Hence, this was taken forward to the second-stage inquiry.
- **Procurement management:** Contract packages were centrally awarded by the AAI following appropriate process at the conclusion of the planning stage. The engineering, procurement, and construction (EPC) lead contractor submitted the baseline procurement and construction works program for review on November 26, 2008. It included the following:
  i. Passenger terminal building (approximately 223,000 sq.m.) comprising the international and domestic terminals, including pile foundations, as well as all civil and finishing works;
  ii. Car park building;
  iii. Elevated road in front of the passenger terminal building;
  iv. Aluminium works, façade, and glazing system;
  v. Profile roof sheeting system;
  vi. Internal and external electrification, lighting, and so on;
  vii. Power supply including diesel generator (DG) sets;
  viii. Central air-conditioning;
  ix. Elevators, escalators, and travelators;
  x. Fire-fighting systems (such as automatic hydrant and sprinkler system).

The final scope of the work for the main contractor was amended to include all major civil and electrical works but exclude the works for aluminum works, façade, and glazing systems. Moreover, the baggage handling system, sewerage treatment plant, passenger boarding bridges, building automation system, and information technology (IT) packages were procured through separate contracts. The procurement, fabrications, and deliverables were planned until October 26, 2010, which was subsequently revised thrice to cater to delays in site handover and to match the progress of construction works. Procurement administration during execution stage followed standard procedures. Hence, it was not considered for second-stage inquiry.

- **Stakeholder management:** A project such as this has multiple stakeholders, which continue to expand as it moves through its development life cycle: planning (mostly internal and regulatory stakeholders) to construction (mix of internal, regulatory, and some external agencies) to commissioning (heterogeneous mix of internal, regulatory, and proportionately larger base of external agencies, as well as the public at large). The

stakeholder management processes across the project life cycle were appropriately executed; this factor was taken forward for second-stage inquiry.
- **Safety management:** The project area was cordoned off from the apron and other operational areas (both air and city sides). Construction staff and equipment safety measures were in place. Location of the operational aviation turbine fuel storage area near the construction site (on the fringes of Zone 6) required additional safety measures during construction. However, as the overall safety record of the project was good, this was not taken forward to the second-stage inquiry.
- **Environment management:** Water bodies and natural aquifers are protected; environmental clearance for filling them up is likely to take time. However, no environmental clearance was necessary for filling up of pond inside the project area. This was identified as an advantage for this project. Other clearances were obtained during project planning and hence this area was not taken up in the second-stage inquiry.
- **Financial management:** The AAI released funds commensurate with progress of work. In turn, the main contractor released funds to the subcontractors and equipment suppliers. More often than not, if this funds flow cycle gets broken, schedule performance gets affected through the affected actor(s). There was no such finding, and hence this area was not picked up for further study.
- **Claim management:** Though claim resolution is a PMI closure process, in practice and also as seen in this project, execution of works deviating from baseline project plan need concurrent handling of claims during execution. As the execution stage of this project had multiple deviations from the baseline project plan, this knowledge area was considered for further study. It may be mentioned that both the AAI and the contractors demonstrated commitment to avoid disputes that would result in stoppage of work while continuing to work on claims on a parallel track. This was taken forward to the second-stage inquiry.
- **Integration management:** Young and Poon (2013) commented that methodologies such as PRINCE2 and PMI (Project Management Body of Knowledge [PMBOK]) have been found to be mature but ineffective without project governance and top management support. Following this, both project governance and top management support were examined in this stage of inquiry.

A recent study on large multi-stakeholder infrastructure projects shows project governance shifting toward (a) emphasizing network-level mechanisms, such as self-regulation within the project and (b) taking an open-systems view to successfully manage such projects in complex and challenging institutional environments (Ruuska et al. 2011). The commissioning stage of this project was an example of such a challenging institutional environment, wherein the complexity of decision making in a multi-stakeholder environment attained its peak within the project life cycle. Hence, this knowledge area was chosen for second-stage inquiry.

Top management support was crucial to achieve success in this project. For example, a high degree of coordination was needed between project activities and maintenance of existing airport operations, such as traffic diversions, work permits, executing utility rerouting works, transitioning, and commissioning. In this case, the airport Director himself held the charge of the project. A common, on-site top executive ensured necessary support during the execution stage and streamlined interdisciplinary coordination between projects and operations. It is a key learning from this project and can be considered a good practice for similar other projects.

6.2 Conclusions from first-stage inquiry

As discussed earlier, six knowledge areas – namely, integration management, time management, resource management, risk management, stakeholder management, and claim management, were shortlisted for building the second-stage inquiry and study of schedule delay recovery measures. In addition, lessons from knowledge areas such as cost management and quality management were noted for consideration during development of conclusions.

7 Second-stage inquiry

The second-stage inquiry was intended to identify and categorize constraints in the performance of shortlisted knowledge areas. The approach and logic followed in the process are discussed in the following sections.

Following a GT approach, open coding was undertaken to collect granular text data through interviews of key project executives (in civil, mechanical-electrical-and-plumbing [MEP], and planning divisions) of the AAI and the deputy project manager of the EPC contractor; site visits, study of progress reports, schedule variance analyses, as well as inspection of drawings and other project records. Open coding identified 10 key constraints, which were grouped into a core of seven “anchors” similar in concept in terms of situations, constraints, and schedule impacts. Three broad groups (termed "categories") were then generated by aggregating these "anchors" based on similarity in findings (Table 4).

The open-coded constraints were ranked, using a concordance approach among the AAI project executives and contractor representatives. The criteria for ranking the constraints were as follows: (a) those that had an impact on schedule performance and could be quantified; (b) those that demonstrate evidence of impact on schedule but could not be quantified; and (c) those with descending order of criticality and potential to impact schedule but were effectively managed. A summary of this analysis is presented in Table 5.

As the next step, the top-ranked five constraints, which affected (or had the potential to affect) the project schedule, were studied to understand how the AAI managed them following the five shortlisted PMI knowledge areas, namely, integration management, time management, resource management, stakeholder management, and claim management, discussed in the previous section.

Tab. 4: Mapping of anchors into categories.

Anchor	Category
Land encumbrance Access restriction Knowledge of existing utilities network/layout Reclamation of land/brownfield contamination	Site constraint
Cascading planning deficiency	Process constraint
Complex, multidisciplinary decision-making environment Organization procedural environment	Governance constraint

8 Analysis of findings of second-stage inquiry

8.1 Site constraint (land encumbrance)

Brownfield projects are seldom simple, straightforward development efforts (Harrell et al. 2004). For a project of this magnitude and complexity, designed to be built on international standards, handing over encumbrance-free land within the project premises to the contractor was a critical prerequisite for commencement of construction. This was a "known" risk at the planning stage. However, an extraordinary delay in handing over the land parcels turned out to be a crucial shortcoming on the part of the AAI, creating uncertainty in activity and schedule management, thereby escalating it into the realm of an "unknown" risk. Consequential disruptions had a disproportionately wider adverse effect on the overall project performance when compared to all other constraints.

8.2 Relocating line maintenance building, its demolition and handover of site

Identification of an appropriate location to shift the line maintenance building took time and could have been done earlier through better decision making during planning. However, once the line maintenance staff had relocated, the AAI project team executed demolition works by mobilizing additional resources at their end and handed over the parcel of land to the main contractors to start construction works. For the entire works of Zones 3 and 4, which were constrained due to maneuverability issues and had access restrictions (being close to existing airport operational areas), the AAI and the main contractor's team connected well and worked with a high degree of alignment between them, with the contractor showing commitment and adaptability to mobilize additional resources to avail windows of schedule recovery opportunities and the AAI reciprocating by providing as much facilitation as possible within contractual provisions and operational constraints. Such mutual adaptation to achieve the common goal demonstrates ambidexterity (Gibson and Birkinshaw 2004). Though the handover for this area (Zones 3 and 4) was delayed by 1 year, the net delay attributable to this site constraint was finally recovered and was assessed at 2 months. This delay would have affected the completion of Phase 1 if the AAI had pursued a bifurcated completion approach for Phase 1 (covering Zones 2–6 by July 2012) and Phase 2 (covering only Zone 1 by March 2013).

8.3 Identification of a location for the service building and sewerage treatment plant

There was delay in identification of the locations for structures near the Integrated Terminal Building. While some delay could not have been avoided because of the uncertainty in finalizing locations for other relocations, it could have been done earlier through better decision making at the planning stage, compared to the 1 year it took. In this period, the excavated earth from the pond area, where piling was in

Tab. 5: Description of key constraints, anchors, and categories, as well as their effects on project schedule.

Description of situation and constraint	Anchor and category	Effect on project and consequential delays	Rank
Shifting of electrical substation; permission for demolition of link building. These were critical pieces of operational infrastructure located in Zone 1 of the proposed Integrated Terminal Building.	*Anchor*: land encumbrance; *category*: site constraint	Link building area was handed over on April 1, 2011, about 29 months after commencement of construction.	1
Shifting of line maintenance building and motor transport workshop and permission for demolition. These were operational facilities located in Zones 3 and 4 of the proposed Integrated Terminal Building	*Anchor*: land encumbrance; *category*: site constraint	Line maintenance building area was handed over on October 20, 2009, about 1 year after commencement of construction.	2
Service area, its building, and the underground sewerage treatment plant were not defined in the initial plan drawings.	*Anchor*: land encumbrance; *category*: site constraint	The locations were finalized 1 year after commencement of construction.	3
Inclusion of separate architect/design consultant for Domestic and International terminals, with no interface between the consultants, resulted in major disorder when the structure was designed as an integrated terminal.	*Anchor*: cascading planning deficiency; *category*: process constraint	Dissimilar architectural concept and design outputs with convergence disagreements between consultants resulted in time loss. This time loss affected the schedule performance but could not be segregated and quantified in the study.	4
(a) The AAI had no prior experience of such a large commissioning exercise since its inception in 1994. (b) Transition of all operations staff, airlines, passenger, security, health organization, customs and passport control services. Operations from existing terminal buildings were planned to be shut down.	*Anchor*: complex, multidisciplinary decision-making environment; *category*: governance constraint	Any glitch in transition would delay project commissioning. Other high-profile international airports experienced commissioning fiascos. Meticulous planning and rigorous trails ensured smooth transition, and hence this was picked up for detailed study.	5
Without restricting appropriate access for existing airport operations, there was limited space available to be given to the contractor for setting up the fabrication yard, Concrete batching plant and its operations, and equipment storage. Maneuverability of equipment and vehicle were also constrained within the project area.	*Anchor*: access restriction; *category*: site constraint	Lack of proper road network within the project area led to equipment underutilization and hindered movement of project resources. This, however, finally did not cause project delay.	6
Rerouting of existing operational utilities, services, and communication cables from the project area in the absence of their detailed drawings. Most of these were serving the existing airport, and any inadvertent damage during excavation or other works would be potentially disruptive for airport operations.	*Anchor*: knowledge of existing utilities network/layout; *category*: site constraint	While this was a “known unknown”, it led to uncertainty with potential to affect schedule. This was managed by the AAI with additional efforts and emerged as a learning point from this study.	7
(a) There was a storm water pond in the project area, which needed to be filled up as a part of site preparation activity. (b) Rerouting of inlet to pond and its discharge into the existing drainage system of the civic authority	*Anchor*: reclamation of land/brownfield contamination; *category*: site constraint	Though pond filling activity was planned, the rerouting of the inlet to pond was not initially budgeted. This was included as a revision, but finally, it did not delay the project.	8
Location of operational aviation turbine fuel storage tank area near the project construction site (on the fringes of Zone 6). This required the following: (a) implementation of additional safety measures during construction (b) maintenance of access roads for tankers approaching from the city side to the fuel storage tank area throughout the construction period.	*Anchor*: land encumbrance; *category*: site constraint	Efforts to get the fuel oil marketing firm to relocate their fuel storage tanks did not materialize and needed repeated changing of temporary access roads to allow tankers to reach the fuel storage tank area. No delay in project schedule.	9
Lengthy organizational procedure for effecting any change in contract, such as Bill of Material, specifications, quantities, services, and other change orders that may become necessary during project execution.	*Anchor*: organization procedural environment; *category*: governance constraint	Layouts or numbers were required to be shared and agreed with the contractor to know the flexibility on the availability of material or substitutes and their construction viability before implementing the drawings for construction purposes. No delay in schedule.	10

progress, had been moved to this area and required reshifting. This duplication of work could have been avoided. However, the AAI project team recovered this schedule delay through additional mobilization of resources, round–the-clock working, and resequencing of activities. Finally, this caused no net delay to the overall project schedule.

8.4 Demolition of link building and handover of site

The uniquely situated city of Kolkata serves as an aviation gateway between the seven land-locked North East Indian States and other Indian Sates, which otherwise are not well connected by road or rail and are serviced by limited number of flights. The link building served as an affordable transit accommodation for convenience air travelers to the North Eastern States. The impact of a demolition decision of the link building needed to be assessed beyond the project contours, and its approval was caught in procedural and contextual delays. This shows that there was a need for a more comprehensive stakeholder consultation at the outset of such public infrastructure projects and working out acceptable alternate arrangements before commencement of execution works. Recent studies have shown how sociotechnical spaces across boundaries can be consultatively bridged to overcome barriers and provide better insights into their needs, values, and concerns at an early date (Storvang and Clarke 2014).

The demolition was further complicated by the presence of an electrical substation, which serviced existing airport operations, within the link building premises. The AAI had to shift the substation by erecting and commissioning another substation outside the project area (which took nearly 1 year) to continue servicing existing airport operations. Finally, the link building was demolished, and the site was handed over after about 29 months from the date of construction commencement. Besides creating access restrictions to continue working in other areas, the link building had held up construction of 36,818 sq. m. floor area across all levels (about 16% of the total floor area). This factor singularly caused a major delay and disruption in this project.

Even before the entire construction site could be made available due to land encumbrances, piling work was commenced by the contractor. To facilitate movement of piling rigs, cranes, and dumpers, the AAI made a special effort to shift the gas bank of the operational restaurant in the existing domestic terminal building, which was very close to the construction works area.

Once the link building area was handed over, special efforts were made by the AAI and the contractor to expedite and recover schedule delay to the extent possible. On the basis of the prior learning in managing execution of resource-intensive critical activities in the areas of Zones 2–6, activity related to erection of trusses was resequenced and prioritized indicating ambidexterity. Some specific examples of exploratory learning during the construction activities of Zones 2–6, which were exploited to achieve schedule efficiency in Zone 1, are given below:

- After fabrication and shifting of the roof truss segments from the fabrication yard to the site, the average time required from assembly to erection of each truss was 35 days. With the learning experience and hands-on expertise of the erection team gained from the erection of 30 trusses in Zones 2–6, it was possible to reduce the time cycle to 29 days for each for the four trusses in Zone 1. This was possible by reducing the time taken for making arrangements for the temporary and enabling works on steel and reinforced cement concrete (RCC) columns to facilitate the erection.
- From the learning experience of Zones 2–6, the location of the two tower cranes erected in Zone 1 could be better planned. The utilization of the tower cranes was maximized with minimum hindrance to the casting of floor slabs. The dismantling of the tower cranes was also completed with least hindrance and less time.
- The false ceiling works at both the arrival and departure levels were specialized activities requiring workforce skilled for quality and precision execution at ceiling levels of 9 m and 16 m (average) above their respective floor levels. The exploratory learning while executing similar work in the other zones resulted in knowledge that helped reduce defects and rework in Zone 1. Consequently, the same portions of work in Zone 1 took lesser time to complete.
- In the lower basement, there were interfacing issues between the main and the baggage handling system contractors during the execution of works in Zones 2–6. This was related to the structural supports for the conveyor belts suspended from the ceiling. Resolutions were explored and mutually agreed upon, and this knowledge helped better plan and execute the services and utility lines in the basement ceiling in Zone 1 without any hindrance.

Discussions with the AAI project team and the contractor revealed that the overall net delay could be contained to

7 months, attributed to recovery measures in spite of site constraint in Zone 1.

8.5 Validation with literature

One of the first ambidexterity studies on large, complex, engineering projects was on the USD 920 million Sutong Bridge construction project in China (Liu et al. 2012). The bridge, apart from its huge span, has the deepest bridge foundation piles (120 m) in the world. Its two 300.4 m towers rest on the world's largest pier base (the pile cap), which is anchored on 131 friction piles cast deep into the riverbed. By studying the piling works of the Sutong Bridge project, the researchers concluded that ambidexterity was achieved during the life span of this complex engineering project. This was done by exploring new solutions in the first phase of the piling work after an initial setback and then exploiting the newly acquired knowledge to expeditiously complete the piling works. Similarly, in the NSCBI Airport construction project, it was seen that exploratory learning in Zones 2–6 was exploited to achieve schedule efficiency in Zone 1. This indicated ambidexterity.

8.6 Process constraint (*cascading planning deficiency*)

The earlier stand-alone expansion and modernization project for the international passenger terminal building, drawn up in the year 2006, had already engaged a national architectural design firm. The initial contractual disbursement had happened, and the firm had commenced work. The AAI also had engaged another architectural design firm in the year 2007 for its earlier separate and stand-alone expansion project for the domestic passenger terminal, which was put on hold when the AAI decided to conceptualize the Integrated Passenger Terminal Building in that year.

The international architectural firm, chosen for the integrated terminal in 2008, had already forged a pre-bid partnership with the already appointed Indian design firm for modernization of the domestic terminal building. Thereafter, during the planning process of the Integrated Passenger Terminal Building, architects of the earlier stand-alone expansion and modernization of the international passenger terminal building (engaged in the year 2006) were requested to join the design team for the new project on mutually acceptable terms. This was primarily done to leverage the disbursement already made under their earlier contract, which otherwise could have been classified as infructuous expenditure according to public sector practices.

8.6.1 Lack of convergence between architect-designers

As found during the study, this arrangement of two architect-designer firms with dissimilar architectural concepts and design outputs working on an integrated terminal led to multiplicity of issues for the AAI and the contractors. This adversely affected project progress and possibly outweighed the savings made had the initial disbursement to one of the designers been declared as an infructuous expenditure. This has been categorized as a process-cascaded constraint, wherein decisions taken during preceding planning process group discussions become binding constraints on the succeeding execution process group working. Furthermore, this stands out as an example of an unidentified risk during the planning stage, which turned out into a schedule-threatening risk soon after construction commencement.

Civil, architectural, and MEP activities require high level of interface and coordination among the actors (architect-designers, contractors, and consultants) and their activities. Independent interface drawings need to be developed to prevent dismantling and reworks. The issues must be resolved regularly with intensive interface meetings as demanded. Poor interface leads to time and cost overrun and claims by the contractor. Survey findings from Thailand on similar construction projects have also revealed that factors related to designers, contractors, and consultants were among the top problems (Toor and Ogunlana 2008).

In this project, good-for-construction (GFC) drawings were planned to be provided in complete within the first 8 months of the project, which continued very late into the construction stage and did not include the baggage handling system and the IT packages, generating clashes subsequently. The total GFC drawings received on the project were 3,358, including revisions, of which civil (including structural steel) comprised 39.22%, architecture 34.70%, and MEP 26.08%. In total, 75.08% of the first issuance of GFC drawings were revised (this led to a total of 1,440 revisions), indicating very low convergences between the two architect-designers before releasing the GFC drawings of the integrated terminal.

Furthermore, the architect-designer responses to request for design and architectural information by the contractor were delayed. This cascaded into delayed submission of shop drawings by the contractor, and the approval of shop drawings was further delayed by the design consultants. Missing information and inadequate details had considerable effects on the progress of the project. There were 3,103 revisions submitted by the contractor, which is 52.48% of the original submissions. Substantial revisions (totaling 2,635) were in structural steel, which was a major issue for preparing shop drawings.

8.7 Measures taken by the AAI

Under such uncertain conditions and delays that required schedule crashing, leaving even lesser time for completion of works, the lack of architect-designers' representative on the project site to review design and provide quick on-site resolutions that were necessitated due to site constraints aggravated matters. In many cases, the AAI had to draw upon in-house, prior learning of experts to directly intervene and provide solutions to contractors, thereby expediting works. At the same time, the AAI simultaneously explored ways to work around site constraints that delayed the release of GFC drawings. In this context, the AAI took the lead across all stages of construction work to integrate the views of disagreeing architect-designers, thereby narrowing down areas of divergence. In the process, the AAI suggested multiple design and layout changes to make the structure efficient for optimal use.

8.7.1 Validation with literature

March (1991) conceptualized ambidexterity as organizational learning in terms of exploitation (drawing from prior learning) and exploration (developing new solutions), which were earlier considered to be competing for scarce organizational resources. Another research showed nine principles of "simultaneous management" to be the key to the execution of capital projects with excellence and speed (Laufer et al. 1996). While six of these principles pertained to planning and systems, three of the leadership and integration principles, namely, inward and outward leadership, multiphase integration, and multidisciplinary teams, were adapted by the AAI to overcome this constraint and recover schedule delays. Such "exploitation and exploration" and "simultaneous management" can be assessed as demonstration of ambidexterity.

8.8 Governance constraint (complex, multidisciplinary decision-making environment)

8.8.1 Criticality of this activity

Commissioning of such a large-scale Integrated Terminal Building was the first-of-its-kind experience for the AAI. While this was a "known" risk, in the absence of any in-house hands-on prior experience within the AAI, no mitigation planning was done before commencement of construction. In India, the newly built Delhi Airport Terminal-3 was commissioned in the year 2010, but it dealt with partial transition activities as some of the airlines continued their operations from the existing Terminal-1. The AAI was aware that the wider public perception of project success was dependent on achieving an incident-free commissioning on Airport Opening Day (AOD). Hence, it was critical for the AAI to demonstrate that it could orchestrate multiple stakeholders and govern them to work cohesively toward this common goal.

8.8.2 Measures taken by the AAI

To exploit prior learning available in India, the AAI facilitated a transition peer review, whereby representatives from the Delhi Airport Terminal-3 project were invited to share their experiences. A detailed transition work plan for the successful transitioning of people, processes, systems, and supplies was then drafted to ensure a smooth opening with uninterrupted operations in the new environment. Furthermore, as another learning measure, two actual arrival flights were taken through the new terminal in July and August of 2012 as a trial measure. All arrangements that a passenger would expect while passing through the terminal were trial-commissioned and the exercise was successful in a controlled environment. These systems were then subjected to rigorous testing over the next few months to iron out glitches.

Being aware that there would be no scope for on-the-spot improvisation on AOD, the AAI took the lead to draft a set of standard operating procedures (SOPs). These were then reviewed by the airlines, the security agency, statutory authorities, customs and immigration departments, and the airport health organization for operational suitability, as well as their conformity with the laid-down rules and regulations before their adoption. The AAI realized that effective communication of SOPs to all stakeholders held the key to success and dedicated significant efforts in this direction.

The AAI then developed an operational readiness, activation, and transition (ORAT) program to identify opportunities for improvement and corrective actions prior to AOD and, if necessary, resolve any conflict between the design and the intended operational usage. The AAI extended extensive assistance to all stakeholders to overcome the challenge of maintaining parallel sets of synchronized, operational systems at the existing and new terminals during transition. ORAT review meetings were held weekly to monitor progress and resolve issues through on-the-spot decisions for schedule compliance. Necessary statutory approvals from the Central and State Governments (passenger boarding bridges, security, power supply, DG set fuel storage, fire and emergency rescue, weights, and measures) were obtained on time – well before AOD.

Shifting of flights from the existing terminals to the new terminal commenced from March 10, 2013, and the entire process was completed by March 15, 2013. The collaborative approach-based ORAT ensured that the four essential factors in airport operations – passenger, airport, baggage, and aircraft – harmonized to ensure complete alignment of facilities, people, and processes for the successful launch of operations on time, on budget, and without incident.

8.8.3 Validation with literature

The problems faced by the Heathrow Terminal 5 on AOD, culminating in the cancellation of numerous flights and manual sorting of thousands of lost bags before being returned to their owners (Brady and Davies 2010), show that one of the best-planned high-technology construction efforts of recent times delivered within time and cost can go awry at the commissioning stage. The AAI was aware of the numerous problems the Heathrow Terminal 5 faced on AOD, and the NSCBI Airport's Integrated Terminal faced none of these issues.

A business study on the "alignment" (exploitative qualities) and "adaptability" (explorative qualities) collected data from 4,195 individuals in 41 business units and found a strong correlation between company performance (dependent variable) and high levels of both alignment and adaptability (Gibson and Birkinshaw 2004). The researchers termed this phenomenon as ambidexterity. Similarly, at the commissioning stage of this project, the AAI achieved high levels of alignment to integrate all stakeholders toward the common goal of incident-free AOD and adaptability to a situation of contending demands under uncertainty, yet exploring new solutions. Hence, it can be concluded that the underlying phenomenon of AAI's project governance was ambidexterity.

9 Summary and conclusions

It was quite likely that the execution stage of such a large brownfield extension project that began with deficiencies in the planning process would generate a set of disparate disruptions as soon as execution commenced. The combinatorial effect of these disruptions not only posed serious challenges to execution within budgets but threatened to worsen the already-projected schedule delays. The two-stage inquiry model brought out and ranked the constraints with their impact on schedule delay. Case findings showed that the AAI worked with the simultaneous objectives of minimizing the impact of disruptions and instituting measures across multiple dimensions of the project to recover schedule delays. Though working in a state-owned enterprise environment, the AAI project managers took many good decisions in a far more systematic and expeditious manner than many of their peers in other similar enterprises to speed up the recovery process. The case findings also show that all recovery measures were instituted for every significant constraint/issue, having a balance of simultaneous exploitation of prior learning and exploration of new solutions. A summary of this assessment is given in Table 6.

It can thus be concluded that ambidexterity was the underlying phenomenon of significance in schedule recovery measures instituted by the AAI. The study of schedule recovery during the execution stage of delayed capital projects is a relatively less-researched area. The emphasis of previous studies has generally been on improving the planning processes to achieve project success. However, in practice, planning deficiencies are widely prevalent when construction projects (especially in developing countries) are conceptualized and sanctioned. Executions of these projects are either delayed or get disrupted, in addition to facing cost overruns and disputes. These projects need to be recovered. While some of the delay factors are related to land acquisition, rehabilitation, and environment clearances (especially for greenfield projects In India and many other developing countries), there are a large number of brownfield projects that do not have such challenges but still face inordinate delays and disruptions.

Though case findings cannot be generalized to support any hypothesis, it can be a source for contextual evidence and rich insights (Walker and Shen 2002). As this case shows, such projects can turn around their

Tab. 6: Assessing the underlying phenomenon in the schedule recovery measures.

#	Constraint category	PMI knowledge area applied for schedule recovery	Schedule recovery measures and their underlying phenomenon
1	Site constraint	(a) Time management (b) Resource management (c) Claim management (d) Integration management	Managers moved away from conventional practices of activity scheduling to orchestrate all project resources and dynamically operated in a turbulent environment within less time, without sacrificing cost and quality, in addition to handling emergent claims effectively. The AAI intervened when needed to exploit prior in-house (or externally accessed) learning and explore new solutions by integrating stakeholders within the available time to deliver the project. All these steps demonstrated ambidexterity.
2	Process constraint	(a) Time management (b) Integration management	
3	Governance constraint	(a) Time management (b) Resource management (c) Stakeholder management (d) Integration management	

AAI = the Airports Authority of India.

performances during execution by improving their managerial effectiveness through appropriate application of ambidexterity principles. This could be adopted as a model of good practice by practitioners looking to institute recovery measures in delayed and disrupted projects. This study considered a brownfield project; however, the inquiry models and analytical framework developed can be applied to greenfield projects as well. Future research could consider projects from other infrastructure sectors to help build a wider body of research knowledge to support project managers engaged in recovering delayed projects.

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